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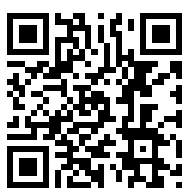

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THE ROYAL ENGINEERS JOURNAL.

Vol. VII. No. 1. JANUARY, 1908.

CONTENTS.

	PAGE.
1. **Design and Construction of Large Workshops at the Gun Carriage Factory, Jubbulpore.** (*With Photos and Plate*)	1
2. **Reminiscences of the Siege of Delhi, 1857.** (*With Plate*). By Major-Gen. W. E. WARRAND, D.L., late R.E.	9
3. **Recent Improvements in Incandescent Lamps.** By Prof. J. T. MORRIS, M.I.E.E.	19
4. **Electricity Supply.** By Capt. R. C. HAMMOND, R.E.	28
5. **The School of Estimating and Construction at the S.M.E.** By Lieut.-Col. B. R. WARD, R.E.	32
6. **Memoir:**—General Sir Edward Charles Sparshott Williams, K.C.I.E., Colonel Commandant, Royal (late Bengal) Engineers. By Col. SIR WILLIAM S. S. BISSET, K.C.I.E., late R.E.	43
7. **Reviews:**—*Navigating the Air.* Essays published by the Aero Club of America. (Col. J. D. FULLERTON, late R.E.)	48
The Problem of Flight: A Textbook of Aerial Engineering. By H. CHATLEY. (Col. J. D. FULLERTON, late R.E.)	49
8. **Notices of Magazines**	51

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CONTENTS.

PAGE.

1. DESIGN AND CONSTRUCTION OF LARGE WORKSHOPS AT THE GUN CARRIAGE FACTORY, JUBBULPORE. (*With Photos and Plate*) 1

2. REMINISCENCES OF THE SIEGE OF DELHI, 1857. (*With Plate*). By Major-Gen. W. E. Warrand, D.L., late R.E. 9

3. RECENT IMPROVEMENTS IN INCANDESCENT LAMPS. By Prof. J T. Morris, M.I.E.E. 19

4. ELECTRICITY SUPPLY. By Capt. R. C. Hammond, R.E. 28

5. THE SCHOOL OF ESTIMATING AND CONSTRUCTION AT THE S.M.E. By Lieut.-Col. B. R. Ward, R.E. 32

6. MEMOIR :—

General Sir Edward Charles Sparshott Williams, K.C.I.E., Colonel Commandant, Royal (late Bengal) Engineers. By Col. Sir William S. S. Bisset, K.C.I.E., late R.E. 43

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Navigating the Air. Essays published by the Aero Club of America. (Col. J. D. Fullerton, late R.E.) 48

The Problem of Flight : A Textbook of Aerial Engineering. By H. Chatley. (Col. J. D. Fullerton, late R.E.) 49

8. NOTICES OF MAGAZINES :—

Engineering News. By Capt. C. E. Vickers, R.E. 51

Memorial de Ingenieros. By 'M.' 52

Nature. By Major-Gen. W. E. Warrand, D.L., late R.E. 53

Revista de Engenheria Militar. By 'M.' 56

Revue du Génie Militaire. By Capt. J. E. E. Craster, R.E. 58

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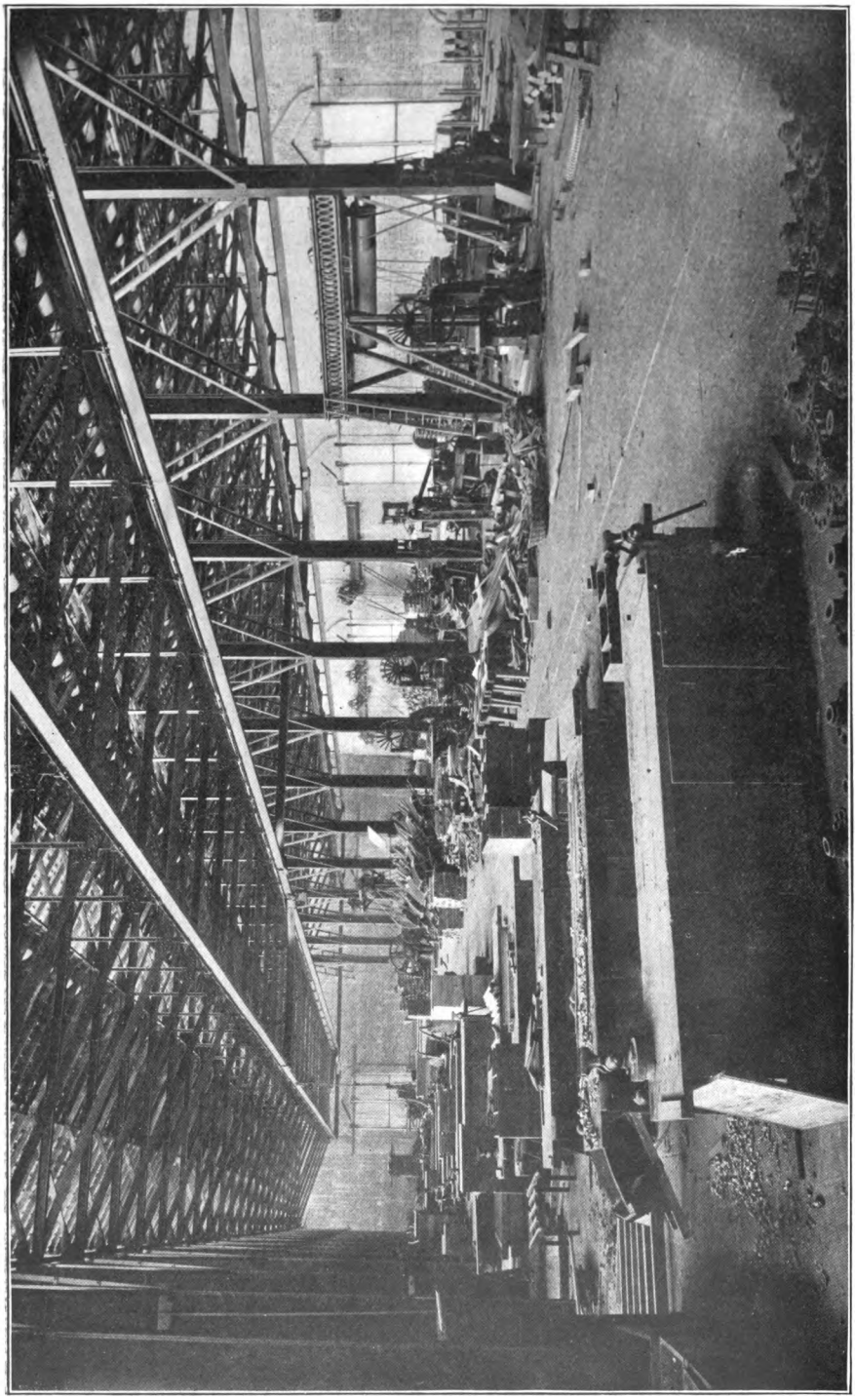
GUN CARRIAGE FACTORY AT JUBBULPORE.



CARPENTER'S SHOP.—Interior—looking S.E.

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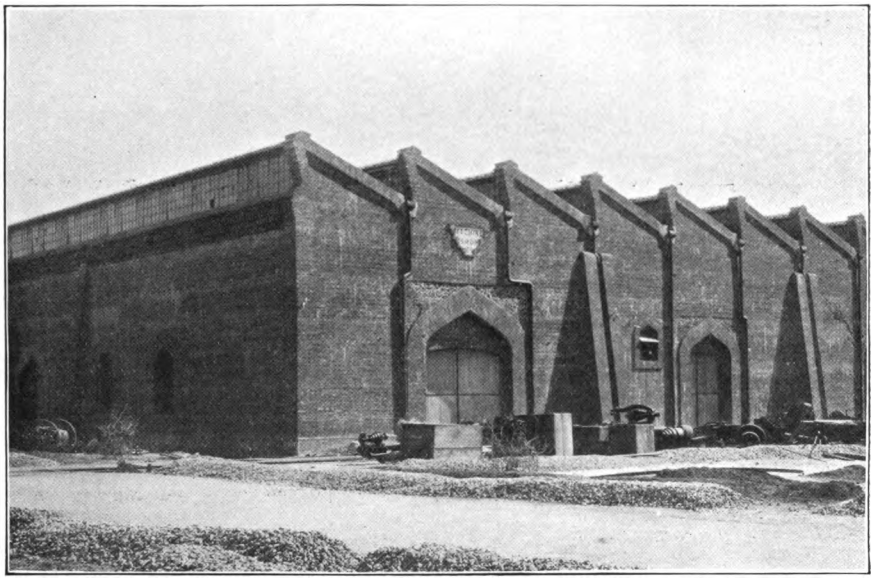
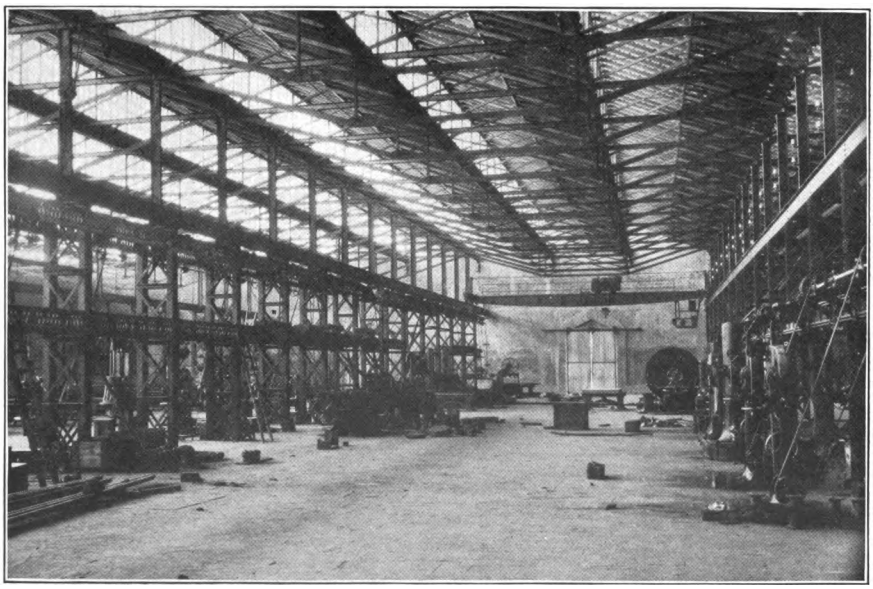
GUN CARRIAGE FACTORY AT JUBBULPORE



MACHINE SHOP.—Exterior—from N.W.



MACHINE SHOP.—Interior—looking E.

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DESIGN AND CONSTRUCTION OF LARGE WORKSHOPS AT THE GUN CARRIAGE FACTORY, JUBBULPORE.

As the design and construction of large shops for manufacturing or engineering works, contain some elements which are peculiar to themselves, and do not come as a rule within the purview of Royal Engineer officers employed on ordinary barrack construction and similar works, the D.G.M.W. in India has forwarded the following report by Major H. F. Thuillier, R.E., on some large shops recently constructed at the new Gun Carriage Factory at Jubbulpore, which may be both of general interest and instructive to those who have similar buildings to design in the future.

The buildings herein described are a machine shop for turning, fitting, and erecting, and a carpenters' shop. They are similar in general design, but differ in dimensions and in certain constructional details. To the carpenters' shop is attached an open shed designed as a sawmill. The machine shop will be first described, and then the points in which the carpenters' shop differs from it explained. The latter having been built after the former was completed, it was possible to remedy in its design certain defects which had shown themselves on the completion of the machine shop. These shops were designed in 1902–03 by Major E. A. Edgell, R.E., data and drawings showing the requirements having been supplied by the Ordnance Department.

Machine Shop.

Dimensions.—The internal dimensions of the machine shop are 270′ long by 250′ wide. The width is divided into five spans of 50′ each, separated by rows of compound steel pillars which carry the roof trusses, the travellers, and the shafting for machinery.

Roof Construction.—The roof over the 50′ spans is carried by truss girders 5′ 6″ deep. The upper boom of these girders is composed of double channel steel bars $6'' \times 2\frac{1}{2}'' \times \frac{3}{8}''$, the tie of flat $6'' \times \frac{7}{16}''$, the struts of double angles $2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{4}''$, and the diagonals of flat $2\frac{1}{2}'' \times \frac{5}{16}''$. The truss girders are carried direct on the standards, which are spaced 15′ centre to centre. The outer ends of the girders in the outer spans are carried on the walls of the building. On these 50′ truss girders the tiled roof is carried in three subordinate spans, each with the north side vertical to give north lighting, and the south side at a slope of 1 in 2·38. The slope in the vertical north faces is governed by the height required to give sufficient light. (See below, *Lighting*).

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These subordinate spans consist each of coupled principal rafters of Sal wood $7\frac{1}{2}'$ apart, butting against a $4'' \times 3''$ rolled steel purlin or bressummer resting on the main truss girders. The heads of the coupled rafters support a $4\frac{3}{4}'' \times 1\frac{3}{4}''$ rolled steel purlin, which in turn carries the Sal wood common rafters $2'$ $6''$ apart. The latter continued upwards rest on a $4\frac{3}{4}'' \times 1\frac{3}{4}''$ rolled steel purlin at the head of the north lights, and their lower end rests on the $4'' \times 3''$ bressummer. A short length of rafter framed on to the upper end of the common rafters forms the northern eaves at the head of the north lights. The vertical north face of each subordinate span is filled in with glazed steel windows, running continuously the whole length of the shop and $5'$ high.

When the building was completed it was found that the rolled steel bressummers and purlins were too light in section and had slightly buckled sideways. They had been calculated according to the usual rules, but the pressures allowed for were the resultants, normal to the slope of the roof, of the weight of the roof covering, occasional loads, etc., and the resistance of the beam had been taken as that through the direction of its greatest dimension. This method of calculation, which is the usual one in roofs, and is shown in the *Military Works Handbook*, makes no allowance for the resultant parallel to the slope of the roof of the external loads. In ordinary roofs, where the feet of the common rafters butt against a wall or are spiked to a wall plate, this resultant is taken up by the wall. When, as in the present case, the feet of the rafters are secured to a bressummer supported at the two ends only, this resultant will bring a lateral strain on the bressummer and purlins and tend to cause them to deflect sideways. This tendency can be guarded against by calculating the bressummers and purlins to resist in the direction of their least dimension the resultant parallel to the roof slope. When this defect was discovered, horizontal iron tie rods were provided, fastening the bressummers to each other and to the outer walls of the building. These prevented further lateral deflection, but did not remove that which had already taken place. The method by which this difficulty was avoided in the carpenters' shop, which was built later, will be seen when that building is being described.

Roof Covering.—The roof covering is of a special patent hexagonal tile, manufactured in Jubbulpore by Messrs. Burn & Co. These tiles proved unsatisfactory from the difficulty of making them fit, and this gave rise to leaks; Messrs. Burn & Co. have now discontinued their manufacture. Other shops in the factory are roofed with tiles of the Mangalore pattern, also made by the same firm.

The main pillars have to carry not only the roof trusses but also a 5-ton overhead electric travelling crane on three of the main spans. Up to a height of $18'$ above the floor, where the gantry way for the overhead crane is set, they are compound pillars consisting of two

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13″ × 5″ rolled steel beams, set 2′ 6″ apart and braced to each other horizontally and diagonally. At the top of the compound pillar is a plate on which is vertically set a single 10″ × 5″ rolled steel joist as a pillar to carry the roof trusses. The compound roof pillars were calculated to bear not only the vertical stresses due to weight of the roof etc., the traveller, the crane and its load, but also the horizontal stresses, both along and across the building, due to the movement of quick travelling cranes liable to be suddenly braked. The latter was taken as 25 per cent. of the moving load in either direction.

Height of the Shop.—The height of the shop is governed by the space necessary to permit of the overhead cranes clearing the lowest member of these truss girders. That, in this case, is 25′ 6″, and the truss girder being 5′ 6″ deep, the height to the top of the upper boom is 31′.

Lighting.—The lighting of the machine shop was originally derived entirely from the north lights in the vertical sides of the fifteen subordinate spans. These lights are 5′ high and run the whole length of the shop. The sashes are of steel, and the two middle sashes in each bay are made to open on horizontal pivots. The proportion of glass area in the north lights to the cubic contents of the shop measured up to wall plate level, is 1 square foot to 100 cubic feet. The lighting, except in the northernmost span is found quite adequate even on cloudy days in the climate of Jubbulpore. For this span, as the bottom of the north light in the roof is nearly 33′ above floor level, the light does not reach the ground for a horizontal distance of about 30′ from the foot of the north wall. The result was that the north side of this span near the wall was too dark to permit of work being properly done on cloudy days and in the late afternoons. Six windows, 6′ wide by 7′ high, were therefore pierced in the north wall to give the required light near the floor of this span.

Roof Gutters.—The gutters along the junctions of the subordinate roof spans are of galvanized sheet iron, semicircular in form, 16″ in diameter. On the upper side a flashing of similar material is provided and carried up under the tiles. The gutters, which are horizontal throughout their length, are calculated to carry off a rainfall of 1″ in five minutes. At the ends of the building the gutters discharge into hopperheads and 6″ cast-iron down pipes. These gutters have proved unsatisfactory, and throughout the two monsoons succeeding their erection leaked incessantly. From various causes great difficulty was experienced in locating and ascertaining the direct cause of the leaks, and various measures were taken without success to stop them. It became evident that the flashing was responsible for part, at all events, of the leaks, and it was eventually concluded that the joints in the sheets composing it were at fault. These joints had an overlap of only ¾″ and the sheets were screwed down to the soling boards underneath.

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The flashing has since been taken up and relaid with 3″ overlap at the joints, and the sheets riveted together instead of being screwed down. A considerable improvement was observed in the portion of the roof which had been treated in this way before the end of the past monsoon, but it is uncertain that it will not also be necessary to treat the gutters themselves in the same manner. (See also remarks under *Gutters* of carpenters' shop).

Overhead Cranes and Tramlines.—In the first and third spans (numbering from the north) 5-ton electric overhead cranes are fitted on travellers capable of being moved the whole length of the shop. In the second bay a similar crane and traveller can be erected when required. The gantry which carries the traveller consists of a 16″ × 6″ rolled steel joist, and is supported on the shoulder of the compound roof pillars at a height of 18′ above the ground. On the north side of the north span the traveller rail is carried on the wall of the building, where an offset to receive it is formed partly by corbelling out and partly by setting back the upper part of the wall, which is of less thickness than the lower.

In Nos. 4 and 5 spans there is a system of overhead tramlines carrying 1-ton travelling pulley blocks, which permits of loads up to this weight being delivered to all the machines in those bays. The tramlines consist of a single 10″ × 5″ rolled steel joist, the travelling pulleys, which are of a special pattern, running on wheels, on the lower flange of the joist. The junctions at points where lines diverge are of a special form, not requiring switches, and were obtained by the Ordnance Department from the makers of the pulleys. The tramline joists are carried on a system of cross girders of 14″ × 6″ rolled steel joists 10′ apart supported on the roof pillars and on an intermediate line of 12″ × 6″ rolled steel pillars down the middle of these spans. These pillars and joists also carry the electric motors and shafting for working the machines in these bays.

Offices.—The shop contains two offices, one 12′ × 11′ for the foremen turner, and one 15′ × 14′ for the foreman fitter and foreman erector. They are raised 8′ above floor level so as to enable the foremen to oversee their workpeople. The spaces underneath are utilized as tool stores. The offices as originally built were enclosed only with expanded metal on wood framing, but in consequence of the heat prevailing in the shops in the hot weather and of the noise of the machinery the expanded metal has lately been replaced by teak panelling and glazing. The offices are built against the end wall of the shop, and each has a small window through the latter, to which a khus-khus tattee can be fitted in the hot season.

Tramways.—The shop is connected with the 1′ 6″ gauge tramway system which is provided all over the factory. A line of tramway goes down the centre of Nos. 1 and 2 bays, and one transverse line enters at a door in the north wall and traverses all the bays, with

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turntables at the junctions with the longitudinal lines in Nos. 1 and 2 bays. In Nos. 3, 4, and 5 bays the tramways only extend a short distance into the shop at both ends.

Broad Gauge Railway.—A branch from the 5′ 6″ gauge railway which serves the factory is carried past the end of the machine shop and has a siding there, so that carriages for repair can be delivered at the doors of the shop and new vehicles removed by rail.

Floor.—The floor of the shop is of 1½″ stone flags on 3″ lime concrete. A wood block floor was asked for by the Ordnance authorities when the building was designed, but this was negatived on account of its excessive cost. The stone floor has suffered—especially near the doors—from the moving in of the heavy machinery, but now that the latter is done it ought not to receive damage.

Doors.—The doors are galvanized corrugated iron sheeting on angle steel framing. They are 10′ wide and 14′ high, except two, which are 15′ wide to admit extra large machinery, etc. The doors are made to slide in two leaves and were originally hung from the top on rollers running on a rail attached to the wall. These doors have given a good deal of trouble. Owing to their weight they constantly jam, and can only be made to slide with great difficulty. The supporting rail was bolted in the middle through the relieving arch, which carries the soffit filling of the main archways. The weight and jar caused some of these arches to fail. The weight of the doors was then transferred to the bottom on rollers running on rail sunk in a reveal in the floor. This saved the arches, but jamming was no less frequent and the rollers often ran off the rail, owing principally to the fact that when the doors jammed the factory operatives attempted to lever them along with crowbars. On one occasion they levered a door off the top rail so that it fell down, fortunately without injuring anyone. Stops were then attached, rendering it impossible for the door to be lifted off the rails. The tendency to jam has not been overcome and probably cannot be so entirely. It is due to the great height and weight of the doors and to the fact that the force used in moving them is applied at a distance below the point of suspension. Leverage takes place, tending to lift the door and cause a jam. The trouble is accentuated by dirt and stones getting into the roller track in the floor. It is altogether an unsatisfactory type of door. In some other shops where similar doors have been provided, but only 7′ or 8′ high, no trouble at all has been experienced. Doors of this large size were specially asked for by the Ordnance Department, but the necessity for them is not apparent. No vehicles that will be made in this shop require openings 10′ wide by 14′ high. The entry of large machinery could have been arranged for by leaving one or two large openings, and when the machinery was got in, bricking up the openings and fixing ordinary-sized doorways therein. This is what was done at the engine house where the machinery erected was larger than

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anything in the machine shop. Smaller doors would have sufficed for ventilation, as ample ventilation can be got from the top lights if desired. Moreover in the hot weather all openings are kept shut to exclude hot winds, and at other times only one or two doors are left open, as it is found that the operatives slip out and evade their work.

The general appearance of this shop from the interior is very satisfactory. It is difficult, however, to get a photograph to show it, and the one that accompanies this article does not do it justice. Standing near the south wall and looking northwards at the roof lights, one gets a view of a very large and almost uninterrupted expanse of sky. The lighting is excellent, and the shop generally is very well adapted to the purposes for which it was designed.

Cost.—The cost of the machine shop up to date, including all alterations mentioned above, has been approximately Rs.2,69,500, which gives a plinth area rate of Rs.3/14/0 per superficial foot.

CARPENTERS' SHOP.

The carpenters' shop is 320′ × 150′, the width being in three spans of 50′. The general design of the roof, with three subordinate spans to each main span, and the arrangement of north lights, etc., is the same as in the machine shop. The roof pillars and main truss girders, however, are spaced only 10′ apart instead of 15′, as in the machine shop. The purlins, being on this account shorter, have not buckled sideways as they did in the other shop, and the general addition to the strength caused by the smaller spacing makes the roof of this shop a very satisfactory one.

Roof Pillars.—As there are no overhead travelling cranes in this shop, the roof pillars are simple 18″ × 7″ R.S. joists. Double angle steel struts are carried from a point 10′ below the top of the pillars, which are 24′ high to the centre of the bressummers. These serve to stiffen the pillars and to give support to the bressummers.

Height of the Shop.—The clear height from floor to underside of truss girders is 18′ 6″, and the latter are 6′ deep over all.

Lighting.—The proportion of glass area to cubic space, measured to top of truss girders, is the same as in the machine shop, *i.e.*, 1 square foot to 100 cubic feet. It has not been found necessary to provide windows in the north wall. This may be due to the fact that the building is less wide, and there is, therefore, more reflection off the south wall; also it is less high, so that the north lights are nearer the floor.

Roof Gutters.—The gutters are similar to those in the machine shop, but they and the flashing have been made to overlap at joints, and the lengths are riveted together. There has been no great leakage. It is probable that sheet-iron gutters of this great length will always leak to a certain extent owing to the joints opening from the expansion and contraction. One curious incident

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occurred in connection with these gutters. During the course of an exceptionally heavy rainstorm the rain water filled the gutters to the brim quicker than it could be discharged by the down pipes. It then overflowed along the whole length of every gutter into the shop. As the rainfall, as measured by a rain-gauge, was considerably less than the calculated capacity of the gutter, this could not have arisen from the diameter of the gutter being too small. The down pipes are 6″ diameter, and these also are big enough to carry off more than the amount of rain that fell. The only conclusion, therefore, was that the flow was restricted at the entrance to the down pipe. The arrangement was that the end of the semicircular gutter was projected beyond the wall of the building over the hopper head, and was closed at the outer end with a sheet-iron plate (see *Fig.* 1); a 6″ circular hole in the bottom of the gutter let the water through into the hopper head. Evidently the water could not get away quick enough through this hole. To remedy this the cast-iron hopper heads were removed, the projecting end of the gutters cut off, and large sheet hopper heads substituted (see *Fig.* 2). These were made so that on the inner side they fitted and were bolted to the semicircular gutter, and the remaining sides were up to the level of the top of the gutter. This allows an unrestricted flow of water into the down pipe.

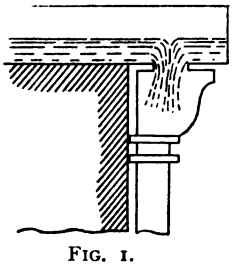

FIG. 1.

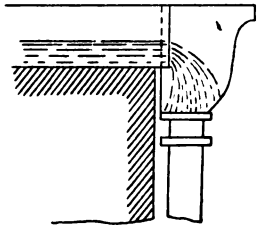

FIG. 2.

No storm of sufficient severity has since occurred to test the efficacy of this alteration, but it is unlikely that the gutters will overflow again. It may be noticed that the machine shop gutters did not overflow during the storm when this happened to the carpenters' shop gutters. This is probably due to the fact that the roof and gutters of the former are 70′ shorter than those of the latter.

Overhead Travellers, Tramways, etc.—There are no overhead cranes, but lines of overhead tramways for 1-ton pulley blocks similar to those in the machine shop exist in two out of the three spans. The joists which form the tramways are suspended from the main truss girders by flat steel hangers with angle clips. The trusses have been calculated to take the additional load of the tramways and their loads. On the floor lines of 1′ 6″ ordinary tramway enter the shop from the end nearest the timber stores, and pass through each bay and out the other end.

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Other Details.—The floor, doors, and other details are the same as in the machine shop. There is also a small office for the foreman.

Basement.—In this shop the machinery is driven by motors situated in a basement under the floor. The floor of the basement is 8½′ below that of the shop, and the latter is carried on brick pillars, rolled steel joists with curved corrugated-iron sheets resting on them, and lime concrete filling to the underside of the stone flags. The basement has only a rammed earth floor, and great difficulty has been experienced in making it dry. During the first monsoon after the completion of the shop the floor of the basement was under water. The subsoil water level in the vicinity of this shop, which is situated on ground that had been partially excavated out of side slope, is even in the dry season at about the same level as the basement floor, and during the monsoon is considerably above the latter. All efforts to pump out the water failed, as it came in as quickly as it was removed. The basement was therefore drained by a complete system of agricultural subsoil drains. The pipes used were glazed stoneware in short lengths, laid with open joints. Four lines of 6″ pipes were given along the length of the basement, with 3″ feeder lines 30′ apart running into them diagonally. A brick inspection pit with stone cover was given at every junction. The drains were 1′ 6″ below the floor at their upper end, and laid at a fall of 1 in 400. At the lower end they were gathered into an 8″ steel pipe, which was carried under the basement floor of the neighbouring saw mills, and thence into the factory main drain, which had to be lowered 3′ to take it. This arrangement was very successful. Throughout the dry season the subsoil water was being drawn off through the outfall pipe, and during the next monsoon not a drop entered the basement. At the latter period the atmosphere in the basement smells somewhat damp, which is due probably to insufficient ventilation, and the earth floor feels at that time slightly damp to the hand. It has not been enough so far to affect the insulation of the motors or conductors.

Cost.—The cost of the carpenters' shop has been Rs.1,91,850, including the drainage of the basement. This works out to a plinth area rate of Rs.3/13/10 per superficial foot, which is a trifle less than that of the machine shop. The fact of its being 7′ less in height than the machine shop is doubtless the cause of its cost being lower even though it has a basement beneath ⅔ of its area.

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REMINISCENCES OF THE SIEGE OF DELHI, 1857.

By MAJOR-GENERAL W. E. WARRAND, D.L., LATE R.E.

F.M. SIR EVELYN WOOD has lately given to the public, through the medium of *The Times*, a series of unconnected incidents of the great Indian Mutiny. There is, I think, a want of due proportion in his accounts of the various phases of the Revolt ; some of the gallant actions in Central India are very fully described, whereas the operations of the Punjab Army, which held the Ridge before Delhi for three long summer months and eventually captured the fortress, are not given in any detail.

Little notice is taken by F.M. Sir Evelyn Wood of the difficulties which the Engineers had to contend with in the siege, and the bold and skilful way in which they were surmounted. The name of General Sir Alexander Taylor, G.C.B., is not even mentioned in his account of the capture of Delhi, although the heroic Brigadier-General John Nicholson wrote to Sir John Lawrence, the Governor of the Punjab, on 11th September : "General Wilson has made everything over to the Engineers, and they, and they alone, will deserve the credit of taking Delhi." And again, on the eve of the assault, he said, " If I survive to-morrow, I will let all the world know that Aleck Taylor took Delhi."

I have therefore thought it advisable to compile a brief account of the siege of Delhi, with especial notice of the work the Bengal Engineers had to undertake in the siege and capture of the fortress.

The defences of Delhi had been strengthened and improved a few years before the Mutiny by Lieut. Robert Napier (the late F.M. Lord Napier of Magdala). They were modernized forms of the ancient works ; the bastions mounted from twelve to eighteen guns each, and were connected by long curtain walls built of solid masonry, 16 feet in height, 11 feet thick at top, and 15 feet at bottom. The circumference was about seven miles, the whole defended by a ditch and a glacis extending 50 yards from the counterscarp, and covering one-half of the walls from the besiegers' view.

On the 7th June General Barnard, advancing from the Punjab, found the Mutineers posted in an admirable position on both sides of the main road two miles from Delhi. To their right was a serai and a walled village protected by an impassable swamp. To their left, on rising ground, a sandbag battery for heavy guns had been constructed. On both sides the ground was swampy and intersected by watercuts. The fight began by a cannonade from the rebel artillery which caused us severe loss. No adequate reply could be

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made; our guns were too few and of too small calibre. The heroic gallantry of the 75th Foot in charging the guns, supported by the 1st Bengal Fusiliers, carried the day, and the rebels retreated hastily towards Delhi, leaving their guns on the ground; our men were much exhausted, but the General determined to push on and seize the Ridge before the rebels could rally or occupy another strong position.

The Ridge, on which the British force was to hold its own against vastly superior numbers for more than three months during the heat of summer and under the rain of the monsoon, rose about 60 feet above the city, and covered the main line of communication to the Punjab, upon the retention of which our very existence as a force depended. Its left rested on the unfordable Jumna; on the right a number of buildings and gardens afforded cover to the enemy, but at the same time impeded them in their attempts to organize an attack in force upon our flank or rear, the latter being well protected by a deep cut from the Najafgarh Jhil. The distance of the Ridge from the city walls, varied from 1,200 yards on our right to over two miles at the Jumna on our left.

Our troops being in position on the Ridge, the problem was, first, to hold our own against the repeated attacks of the enemy, and, secondly, how to take the fortified town in front of us. The first siege train comprised eight 18-pounders, four 8-inch and twelve 5½-inch mortars, with 150 European gunners, chiefly recruits—"a very trumpery affair with which to bombard and take a great city." Our resources in siege guns and ammunition were so limited, daily sorties, disease, and heat were making such ravages amongst our small force, and there was so little hope of receiving any considerable reinforcements, that General Barnard agreed to adopt a project worked out by three young officers of Engineers for taking Delhi by a *coup de main*. Orders were accordingly issued to the troops for an assault early on the morning of 13th June, but by a mistake on the part of the staff a delay occurred; day was breaking, rendering an unperceived advance to the walls impossible; a merciful dispensation of Providence which saved us from what would have been, almost certainly, a terrible disaster, when we think of the hard fighting encountered in the city by a much stronger force on its final capture.

For the next ten days, every day the alarm was sounded, attacks on our position being regularly made by the rebels, and though they were always driven back into the city with heavy loss, yet each attack cost us a number of valuable lives which could ill be spared, and we were practically besieged instead of being besiegers. The sun was the most deadly enemy; on the 23rd June, of ten officers in the 2nd Fusiliers, five were struck down by *coup de soleil* during a desperate attack for the first time on our left flank—as the rebels despaired from their numerous defeats in carrying our position on the right; they were driven back, but our troops advancing too

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far, suffered heavy loss from grape fired from the city walls. Thus ended our twenty-fourth actual engagement with the rebels since the 8th June.

On the 24th June Brigadier-General Neville Chamberlain arrived in camp, bringing with him Lieut. Alexander Taylor, of the Engineers, to act as Commanding Engineer, and it was he who introduced great and vital changes in our tactics. The whole Ridge had remained unconnected by any sort of breastwork; all communications between the batteries and picquets along the road which traversed the length of the Ridge had been effected at imminent peril; the relieving guards, the officers on duty, the orderlies, the native servants, all had to run the gauntlet of the enemy's fire between point to point. Now this evil was remedied, an almost unbroken line of breastwork was run up from the Flagstaff Tower on the left to our extreme batteries on the right. A large serai, with strong stone walls, was taken possession of and held as an advanced post on our right below the Ridge; sandbags were placed on the roof and it was properly prepared for defence, so as to be held by a moderate garrison. It was found to be very useful in preventing the use of the Delhi-Alipore road to the rebels if they tried to turn our right flank. Similarly, an old temple, called the "Sammy House," was occupied as an advanced post on our right centre, guarding against sudden attacks on our Ridge Battery. Experience had taught us the fatal policy of following up the retreating rebels, and orders were given that in future our position should, as far as possible, be purely defensive. When the rebels found that they could not lure a soldier beyond cover of his breastwork, they, too, changed their tactics, and instead of almost ceaseless harass days would now pass without any attack.

General Barnard died of cholera on 5th July, and was succeeded by General Wilson, of the Artillery.

Up to the 15th July the Chief Engineer had urged the General to attempt an assault on the city, but from this time forward, in consequence of our losses, all ideas of active operations against the place were abandoned.

The Engineers were busy in getting ready materials in their park for the construction of the magazines, platforms, etc., necessary for the final siege operations. Lieut. Aleck Taylor had been engaged in the siege of Mooltan in 1848, and this had given him some valuable experience; but all the other Engineers were subalterns, who had had but little or no training in fieldworks since they left Chatham; nearly all had been for several years engaged on roads and canals. Engineers could not be spared for military duty with the sappers, the companies being generally officered by infantrymen. Pasley's Siege Operations were at once studied, and practice in making field magazines, laying platforms, etc., was daily undertaken in the Engineer Park.

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The labour available for the Engineer works consisted of—(1), about 120 of the trained Bengal Sappers who had not mutinied (the only remnant of the regular native army which was now in camp), and they behaved remarkably well; (2), of 800 Muzbees (or low-caste Sikhs), newly recruited as pioneers; and (3), a body of 1,000 common labourers on high pay, whose aid was invaluable from the first in relieving the fighting men from the digging and trenching in such fearful heat, and though without arms and untrained, rendered the most essential service during the siege, and, in spite of many casualties, worked cheerfully under fire. With the passive courage so common to natives, as man after man was knocked over, they would stop a moment, weep a little over their fallen friend, pop his body in a row along with the rest, and then work on as before.

That the siege operations should have been so successfully carried out with untrained men reflects great credit on the Engineers who directed the works, and especially on Lieut. Brownlow (now Major-General H. Brownlow), who, by his incessant activity in the Engineer Park, collected and made up the siege materials and carried out experiments in the best methods of arranging workmen, carrying materials, etc., etc.

On 1st August the actual force in camp may be set down in round numbers at 5,600 of all arms; of these some 3,500 were Europeans and about 2,100 natives; but, then, of the former 800, and of the latter 300, were in hospital, so that there remained fit for duty not more than 2,700 Europeans and 1,800 natives. On the 14th August General Nicholson arrived with the Punjab movable column of 2,000 men. All felt that a great soldier had come among us, full-brained and lion-hearted, and one who would brook no delay in the siege. On the 4th September the siege train arrived. The excitement among all ranks now became intense; Delhi must now be taken within a few days at latest. Sir John Lawrence had despatched from the Punjab the last of his succours, and the city of the Mogul was doomed.

But some uneasily suspected that General Wilson would even now hold back. Anxiety had broken his health, and his nerves trembled as he thought of the magnitude of his task and the probability of failure. The truth was that he had written a few days before to Baird Smith, the Chief Engineer, explaining why it had been impossible to attempt an assault earlier, and saying that though he intended to begin more active operations on the arrival of the siege train, he could not hope to succeed until he was reinforced by the army from England. Baird Smith had insisted in reply that to deliver the assault as soon as possible would be the most prudent course, as the enemy would otherwise have time to learn our intentions and strengthen their defences.

The approach by parallels, that science has taught us how to make

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the siege of fortified places almost a certainty in the success of its results, was now of no service to us. Investment with our limited means was impossible. The attacking force was scarcely one-third of the numerical strength of the enemy, who had still possession of some important suburbs. It was necessary to select a front of attack on which all our available breaching power could be brought to bear. The front to be assailed contained the Mori, the Kashmir, and Water Bastions, with their connecting curtains. These works had, not many years before, been greatly strengthened by our own engineers, so that we well knew the force to be applied to their demolition. This front was selected, 1st, because our left flank would be protected by the river; 2nd, because the flanking fire from the city would be small, as only the Mori Bastion commanded the ground in front of it; 3rd, because there was excellent cover to within a short distance of the walls.

The general plan of attack was that which Baird Smith had projected before he joined the Delhi Army. It was the plan which had commended itself to all our Engineer officers from the first establishment of our army on the Ridge, and which Baird Smith, though wounded and ill, by his influence with the vacillating General, caused to be carried out.

Baird Smith, the Chief Engineer, was much enfeebled by sickness and distress of a painful wound, but when he ought to have been on the sick list he was busy in the works, never losing his high courage or his habitual cheerfulness. His second in command was Aleck Taylor, a man capable of any amount of work and ready for any enterprise. His energy was unbounded, and it was truly a fortunate circumstance that when Baird Smith was too ill to leave his tent, Taylor was ever ready to superintend all the engineering works. He was the heart and soul of every movement—always cheery, always active, never sparing himself, inspiring, aiding, animating all by his noble example. He had the sole executive direction of all the engineering department of the siege batteries which opened the way into the interior of Delhi; on the 7th the first heavy battery was traced 700 yards from the Mori Bastion. It was in two parts, the right of which was to batter the Mori Bastion, while the left was to hold in check the fire of the Kashmir Bastion; this deluded the enemy into the belief that the attack was to be delivered from the right only.

On the night of 7th September No. 1 Siege Battery was commenced; the moon rose on a busy scene, hundreds of camels, arriving, dropped their loads of gabions and fascines, etc., and by daybreak the battery for ten guns, with three magazines, was completed, but only one gun was mounted. The battery was built up to the sole of the embrasures entirely of fascines. We had little loss during the night, for though the noise of the camels, bullocks, etc., must

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have been great, the rebels probably thought it was one of our ordinary working parties cutting brushwood. With the first light, however, the enemy saw what we had been at. The Mori Bastion sent round after round of shot and grape, so that almost every man who ventured from the protection of the battery was knocked over. We had only one gun to reply to the storm, until Major Brind, R.A., dragged a howitzer well to the rear and fired over the parapet. In the meantime we had worked hard in the battery, and as each platform was finished, the artillery were able to open another gun on the enemy. Each shot told with tremendous effect at this range on the masonry, and the fire from the Mori Bastion became gradually feebler and feebler. By the afternoon it had ceased to fire, and was a heap of ruins. The enemy showed great pluck; they often managed to get a fresh gun into action and treat us to a few doses, till they were again silenced. Capt. Baird Smith wrote to Major Brind, R.A.:—"No. 1 Battery was unquestionably the key of the attack, and on its success depended the opening of Delhi to our assaulting columns. The progress of the other batteries depended upon its efficiency, and but for your moral courage, clear perception, and unwavering resolution in arming and working it, in spite of all obstacles, consequences would have followed causing the greatest embarrassment."

The cannonade continued with great effect on the 9th and 10th. Meanwhile the other batteries on the left were being constructed with but little interruption. No. 2, which was to batter down the Kashmir Bastion and breach the adjacent curtain, consisted, like No. 1, of two sections, the left immediately in front of a house known as Ludlow Castle, and the right a little to the right front of the same building; No. 3 was erected inside a ruined office of the Custom House, which the enemy had foolishly neglected to occupy. It was only 160 yards from the Water Bastion, against which its fire was to be directed. It was a happy stroke of genius to surprise the rebels by running up a battery 160 yards from an enemy, with his men lining the walls within easy musket shot. It was a task that required no ordinary nerve and skill to carry out. It was Lieut. Aleck Taylor's unaided idea; he had studied the ground well, and he had seized with quick soldierly eye upon the exact points at which it would be necessary to erect our batteries. He was one who thought nothing impossible, and all men worked under him with the heartiest goodwill. Those who were above him were equally impressed by his noble exertions. "If I survive to-morrow," said General John Nicholson, on the eve of the assault, "I will let all the world know that Aleck Taylor took Delhi." It must be remembered, however, that it was only by the influence of Colonel Baird Smith that the General allowed the siege operations to be commenced, and, when commenced, to be continued to the end.

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General Wilson, in his letter of 20th August to Baird Smith, had pointed out that Delhi was seven miles in circumference, with an immense fanatical Mussulman population and a garrison of full 40,000 disciplined soldiers, with 114 heavy pieces of artillery mounted on the walls, with an unlimited supply of ammunition, besides 60 modern pieces of field artillery manned by trained gunners, and that it was evident to him the results of the proposed siege operations would be thrown on the hazard of a die; "but under the circumstances in which I am placed, I am willing to try this hazard, the more so as I cannot see any other plan to meet our difficulties. I cannot, however, help being of opinion that the chances of success, under such a heavy fire as the working parties will be exposed to, are anything but favourable. I yield, however, to the judgment of the Chief Engineer."

Baird Smith observed on the above:—"This, I think, everyone would allow, places on my shoulders the undivided responsibility for the results of the siege," and Baird Smith was not a man to shrink from the responsibility thrown upon him.

By the 12th September the fire from Nos. 2 and 3 had been most effective—the Water Bastion was a mass of ruins. The enemy, seeing the destruction of their defences, strove hard to make up for their past remissness. Round shot from enfilading guns on our right tore through the interior of the battery from end to end, while infantry, lining trenches fresh made in front of the walls, maintained a galling musketry fire. Yet the British gunners, unheeding their losses, regardless of the fearful heat, went on fighting their guns from hour to hour; never have guns been better served.

On the 13th Baird Smith and Nicholson arranged the plan of assault. Two Engineer officers—Medley and Lang—examined the main breach at 10 p.m., though the Sepoy skirmishers were firing away on their right some 30 yards from them. In five minutes they found themselves on the edge of the ditch, the dark mass of the Kashmir Bastion immediately in front. The counterscarp was 16 feet deep, and steep. Lang slid down first; Medley passed down a ladder and followed him. They saw that the breach was a good one, the slope easy of ascent, and that there were no guns in the flanks. They got back to camp safely, and reported the breach practicable. As the fateful moment drew near General Wilson's heart misgave him, and he wrote to tell Baird Smith that he feared it would be hopeless to assail the Water Bastion; but the Chief Engineer was firm, and promptly reassured him.

On the 14th the assault was delivered at four separate points. Two attacks on the left were directed against the breaches near the Kashmir and Water Bastions, while the 3rd column was to enter by the Kashmir Gate itself, which was to be blown open by an explosion party sent on ahead. This party consisted of Lieuts.

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Home and Salkeld, of the Engineers, Serjts. Carmichael, Burgess, and Smith, of the Bengal Sappers, and eight native sappers to carry the bags of powder. Bugler Hawthorne, of H.M. 52nd Regiment, also accompanied the party to sound the advance when the gate was blown in.

There was an outer barrier gate, which was found open, and Lieut. Home then advanced over the broken drawbridge across the ditch with four men, each carrying a bag of 25 lbs. of powder which they deliberately laid at the foot of the gate. So utterly paralysed were the enemy at the audacity of this proceeding in open daylight that they only fired a few straggling shots, and closed the wicket with every appearance of alarm, so that Home, after laying his bags, jumped into the ditch unhurt. It was now Salkeld's turn. He also advanced with four other bags of powder, carried by sappers, and a lighted port fire ; but the enemy had now recovered from their consternation, and had seen the smallness of the party and its object. Salkeld laid his bags, but was fired upon from the open wicket, not 10 feet distant, and was shot through the arm and leg. He fell back upon the bridge, handing the port fire to Sergt. Burgess, bidding him light the fuze. Burgess was instantly shot dead in the attempt. Sergt. Carmichael then advanced, took up the port fire and lighted the fuze, but immediately fell mortally wounded. Sergt. Smith, seeing him fall, advanced at a run, but finding that the fuze was already burning, threw himself down into the ditch, where the bugler had already conveyed poor Salkeld. In another moment a terrific explosion shattered the massive gate. The bugler sounded the advance, and with a loud cheer the 52nd Regiment sprang through the gateway.

Thus was accomplished one of the most daring acts on record. Salkeld, Home, Sergt. Smith, and Bugler Hawthorne received the Victoria Cross ; but Salkeld, after lingering several days, died of his wounds. Rewards were also given to Havildar (Sergeant) Madhoo Rao and his eight native sappers who carried the powder bags, a faithful and heroic little band, whose comrades were mutineers fighting against them inside Delhi.

Towards evening General Wilson rode down to the city to see what progress had been made. The space between the Water Bastion and the Kabul Gate was in our hands. Lieut. Taylor, of the Engineers, had already taken every precaution for securing our position by loop-holing, fortifying, and garrisoning the captured houses, etc., etc., but General Wilson was not satisfied. Owing to the failure of the right attack, that flank was still exposed, and even the first three columns had done little more than enter the city. Sixty-six officers and eleven hundred and four men had fallen during the day. The mutineers had lost heavily, but tens of thousands of them still remained. General Wilson spoke of withdrawing the troops to our old position on the

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Ridge, but Baird Smith, to whom he turned for advice, insisted on his holding on. On the 15th no progress was made. On the 16th the magazine was taken; but the advance was dreadfully slow, our force was too weak for street fighting. On the 17th the Lahore Bastion was still in the hands of the enemy. The gallant Nicholson was *hors de combat*, and no advance had been made since he had fallen. The exposure of our few fighting men was by all means to be avoided. They had seen enough of it already. They courted no more; and if they consented, it was with manifest reluctance.

Happily, Alexander Taylor was alive, though severely wounded by a bullet in the chest on the morning of the assault. He returned to the city after two days' rest in camp, and suggested at headquarters that each brigade should be ordered to work under the guidance of Engineer officers attached to it, not along the open streets, but through the sheltered houses, during the advance, using them as means of communication. The project met with willing consent, and Taylor and his subalterns went about the work; but the progress was not rapid. On the evening of the 18th they were little further advanced than in the morning, for the Brigadiers did not fall in rapidly with the views of the young Engineers, or cheerfully recognize their temporary supremacy. So Taylor went to the General and drew from him an order to the Brigadier commanding at the Cabul Gate to place at his disposal 500 men to carry out the above-mentioned design, and early on the 19th the advance began in earnest. This was not one of the least of the great services of Aleck Taylor. Working onwards in this insidious but effective way by night we obtained possession of the Lahore Bastion, then the Burn Bastion, and on the 20th the King's Palace and the whole of the city were in our hands.

Thus fell Delhi just three months after the first arrival of the besieging force, and the lion's share of its capture can truly be said to be divided between two men—Baird Smith and Aleck Taylor—both Engineers.

To the former belongs not only the credit of evolving the daring plan of attack, but also the greater credit of taking the full responsibility of carrying out this plan with the small force at his disposal, and that at a time when defeat spelled ruin to the "British Raj" in India. Again, when the general, after the first assault, would fain have withdrawn his weary troops from their almost desperate position, it was due to Baird Smith's firm advice that they were left to cling with grim determination to the hardly-won outworks, from which they were eventually able to force their way into the city.

To Taylor belongs the credit of successfully carrying out the difficult details of Baird Smith's great plan. It was he who, by a stroke of genius, built his batteries right up against the massive walls

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of Delhi, and thus counterbalanced by its proximity the weakness of his ordnance. Finally, when the attack could be pushed no further, and was practically spent, it was his plan of advance which, in spite of the opposition of senior officers, ultimately enabled the sorely pressed columns to cut their way into the city and bring about its complete surrender by the final capture of the King's Palace.

And yet one of our leading generals, re-telling the story in *The Times* fifty years later, makes but a slight allusion to the work of Baird Smith and his Engineers, and omits entirely the name of Aleck Taylor ! !

It is true that this grave omission was rectified after attention had been called to it, but even so it is a curious commentary on the words of John Nicholson :—"The Engineers . . . alone will deserve the credit of taking Delhi," and "If I survive to-morrow, I will let all the world know that Aleck Taylor took Delhi."

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RECENT IMPROVEMENTS IN INCANDESCENT LAMPS.

A Lecture delivered at the School of Military Engineering at Chatham, 7th November, 1907, by PROF. J. T. MORRIS, M.I.E.E.

ALMOST exactly 100 years ago Sir Humphry Davy, working in the famous laboratories of the Royal Institution in London, produced for the first time the phenomenon, now familiar to us, of the electric arc. He produced it by connecting two pieces of charcoal to the terminals of a powerful electric battery, touching the charcoal rods together, and then drawing the carbons apart, when an "Arch of light," or "Arc light" as it is now called, was formed between the two carbons, giving out intense heat and light. This arrangement has since been greatly improved, and is at the present time the most efficient practical method we possess of converting electric energy into light. In passing, it is wonderful to note how varied are the accomplishments of the electric arc, for not only can it give out light, but, with special devices, it can be made to *sing* and *speak*, and, lastly, can be used to send wireless messages many hundreds of miles across space.

But it is not my object to give more than passing reference to this form of electric lighting. We must direct our attention now solely to the other common method of producing light by means of an electric current; that is, by the passage of an electric current through a *thin* solid conductor, which it heats by its passage to full incandescence.

Though not historically in order, I shall briefly describe, in the first place, the Nernst lamp. The light-giving rod in this lamp is made of the oxides of some of the rare metals, the materials not differing very greatly from those which are used in the familiar incandescent gas mantle. It is interesting here to note that Dr. Auer von Welsbach, in his experimental work on improving the electric incandescent lamp, found that it was more commercially possible to apply his researches to an improvement for use with gas instead of electricity, *i.e.*, in the well-known incandescent gas mantle! At a later date the Nernst lamp was developed. It consists essentially of the following parts:—(1), a light-giving rod as mentioned above; (2), a metallic resistance placed in series with the light-giving rod, and (3), a heating coil which can be automatically switched in and out of circuit. In the earliest form of Nernst lamp no heating coil was employed, and the

Nernst Lamp.

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lamp had to be lit by means of a match, thus entirely doing away with one of the distinct advantages electric light has over its rival, gas. Nowadays the heating coil is always employed, and together with it an automatic cut-out, which keeps the heating coil in circuit so long as the circuit is closed and the light-giving rod is not yet hot enough to give out light, but the moment this rod swells out into full brilliancy the automatic cut-out switches off the heating coil. As the light-giving rod in this lamp works in air, no vacuum is required, and the lamp has this further advantage—that it is essentially a high voltage lamp, that is, a lamp better suited for 220 volts than 110. But owing to the expense of the lamp and to the vagaries of the light-giving rod and the cut-out, it has not come into use as much as would have been expected, having regard to the fact that it gives nearly twice as much light for a given electric current as a carbon filament lamp.

Carbon Filament Lamp.

Turning now to lamps of the filament type, of course the most familiar example is the ordinary carbon filament lamp. As is well known, the essential features of this lamp are—(1), the filament is of carbon; (2), it must be wholly enclosed in a glass bulb; (3), the electric current must be capable of being led into and out from this bulb, and (4), the air inside the bulb must be almost completely removed. At the present day the mechanical processes utilized for attaining these objects are very highly developed. The exhaustion of the bulb is begun by mechanical pumps, and finished either by means of special mercury pumps or by chemical means. There is some hope that these methods may be improved by the use of the discovery that Sir James Dewar has made of the attraction of charcoal when cooled to a very low temperature for gases. If, for example, an electric lamp bulb which has only been exhausted by mechanical pumps be connected by means of a glass tube to a small bulb containing finely divided charcoal, and if this bulb containing charcoal be immersed in liquid air, the electric lamp bulb will in a short time be found to be almost completely exhausted of air.

Platinum wires have almost exclusively been used in the best class of lamp for leading the current into and out from the bulb, but of late a seal has come into use which consists of a copper wire of fine diameter, which has been rolled flat for a length of 10 mms., so that the thickness is reduced to ·075 of a millimètre. This extremely thin strip is coated with soft enamel glass and then sealed into the bulb in the usual manner, and, apparently owing to the extreme thinness of the copper, the difference of expansion between glass and copper is not sufficiently serious to cause the two materials to crack away from one another, and so spoil the vacuum.

Possible Materials for Filaments.

We must now turn our attention to the other materials which can be used for filaments, and for this purpose let us study the following table of melting points.

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Melting Points of Elements (Degrees Centigrade).

Copper	... ...	1084
Platinum	... ...	1730
Tantalum	... ...	2150
„ Filament	... ...	2910 (not pure)
Osmium	... ...	2200
Titanium	... ...	2500
Tungsten	... ...	3080
Carbon	... ...	3500

From this table we see that if the highest melting point is to be a guide, carbon would unquestionably be the best material to use. Owing, however, to the fact that carbon, at a very much lower temperature than its melting point, throws off a large number of excessively tiny particles of carbon, if used at too high a temperature, the glass bulb in which the filament is would soon get seriously blackened, and so cut off a portion of the light which the filament is giving. The use of the large bulb in the high efficiency carbon lamp reduces this deleterious effect.

Platinum. Platinum was used in some of the earliest experiments, but, unfortunately, besides its expense, it has the further disadvantage that its melting point is far too close to the temperature at which the filament must be run in order that it shall give a useful return of light for a given expenditure of energy. Hence, commercially, Platinum cannot be used. Tantalum. The next material on our list is Tantalum, and this metal has been used by Messrs. Siemens & Halske with great effect in the now well-known Tantalum lamp.

Osmium. Osmium was employed before Tantalum for a metallic filament lamp, but, partly owing to the fact that its price is even greater than that of Platinum, the cost of the lamp was excessive, and though this lamp may be considered the pioneer of the metallic filament lamps, it is practically obsolete now except for very low voltages.

Tungsten. Tungsten (or Wolfram, its alternative name), a very heavy metal of density about 18, is very largely in use at the present time for the manufacture of metallic filament lamps, and silica is also being used with very efficient results in the Helion lamp. Silicon.

Arrangement of Filament. In the manufacture of these metallic filament lamps we have to contend with a difficulty which is not serious in the case of the carbon filament lamp, that is, the great length of filament required for a given voltage. If we compare these lamps we find that in a carbon filament lamp the length of the filament per 100 volts is from 4 to 9 inches, while in the Tantalum lamp it is about 26 inches, and in the Osram lamp some 20 inches. These great lengths necessitate special means of support for the filament. *Figs.* 1, 2, 3, and 4 show the various methods adopted for tackling this problem. The expansion of the filament has to be allowed for, and adjacent loops of the

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filament must be prevented from touching one another. Some of these lamps, such as the Tantalum and the "Z" lamps, can be used in any position, whilst others can only be used with the filaments hanging downwards in a vertical position.

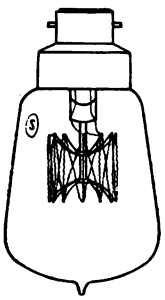

FIG. 1.—*Tantalum*, 110 *v.* 25 *c.p.*

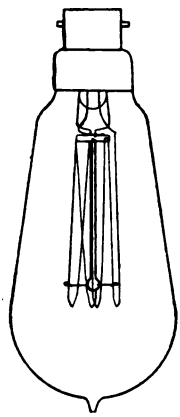

FIG. 2.—*Osram.*

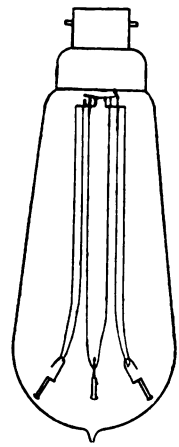

FIG. 3.—*Just-Wolfram*, 110 *v.* 40 *c.p.*

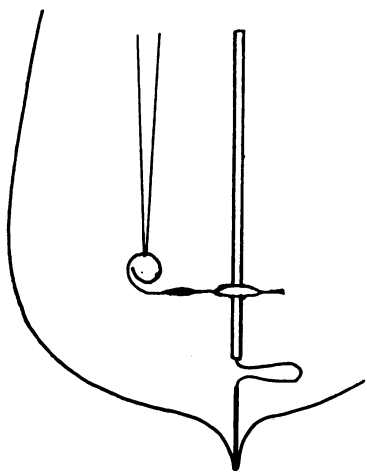

FIG. 4.—*Method of supporting Single Loop in "Z" Lamp.*

Variation of Resistance with Voltage.

We will now study the effect of variation of voltage on the resistance of these different types of lamps. *Fig.* 5 collects together the results. We see at once that carbon, when heated, decreases largely in resistance, whilst Tantalum, Osram, and other metallic filament lamps do exactly the reverse, that is, increase greatly in resistance as the voltage is raised. Quite recently the metallized carbon lamp (G.E.M.) has been introduced. It has an efficiency which is a considerable improvement on the ordinary carbon lamp; its voltage resistance curve is also plotted on this curve. This lamp has the

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characteristic feature of the metal filament, except at very low voltages, when it shows the characteristic of the carbon filaments. One result of these changes in resistance is that on switching a carbon filament lamp into circuit at constant voltage, the initial current is smaller than the final current, whilst with the metal filament lamp the initial current is many times greater than the final current (see Table II.).

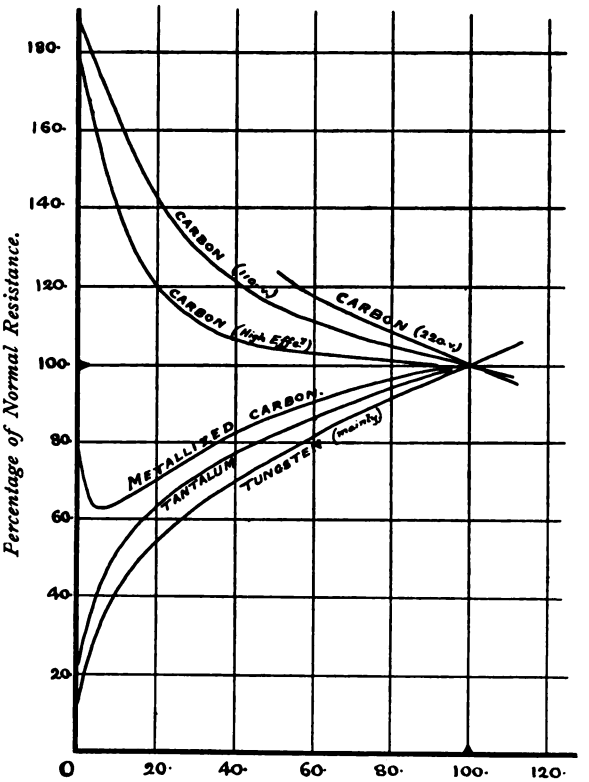

FIG. 5.—*Relation of Resistance to Voltage.*

TABLE II.

Lamp.	Initial Current. Ratio of Final Current.
Carbon	·55
Tantalum	6·0
Osram	8· to 12·
Just-Wolfram	about 12·

A consequence of this, which may be of practical importance, is that the metallic filament lamp lights much more quickly than the carbon filament lamp, and this may possibly be turned to useful account in some forms of signalling. Occasionally, signalling is carried out by means of switching on and off a carbon filament lamp. If in place of a carbon filament lamp a metallic filament lamp were used,

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the signals should be much more sharp, and hence a given number of signals by means of metallic filament lamps should be capable of being sent in a reduced time. The same result could be achieved by using a number of low candle-power carbon lamps in parallel.

Changes during Life of Lamp.

The next portion of our subject deals with the changes which occur in the filaments during the course of their life. The carbon filament, which initially has a bright metallic-looking surface, after running for some hundreds of hours, becomes more or less sooty in appearance, and is then not so useful in converting electric energy into light. The Tantalum filament, when used with direct currents, slowly changes its appearance from that of a smooth bright metallic wire to a wire having a pitted surface; occasionally, too, the wire gets slightly disjointed. When used, however, with alternating currents the Tantalum filament appears to break up into a number of very short lengths, and joins together again, but out of alignment. Some experimenters have even observed when these lamps are at work on an alternating circuit that a tremor goes through the filament lamp for no apparent reason. It has been suggested that the filament actually breaks while working, and the little arc at the contact welds the filament together again, but not exactly in line. However that may be, when a Tantalum filament has broken, it can very often be repaired merely by judiciously tapping the lamp when in circuit, so as to get the broken ends to touch again, when they appear to weld together, and make a really sound joint. These troublesome defects are said to have been considerably minimized in the more recent types of Tantalum lamps. As far as my experience goes, in all metallic filament lamps the material seems to get more brittle as the life of the lamp goes on, and it is not advisable to support these lamps in such a way that they will be subject to vibration during their later hours of life.

Relation between C.P. and Voltage.

Turning now to the effect of the variation of candle-power of these lamps when different voltages are applied to them, we have to accept the fact that all commercial electric supplies do not continuously give exactly the "declared pressure," but that the pressure is constantly fluctuating between certain limits, which on some circuits might well be narrower than they are. If these fluctuations of pressure are not to cause visible fluctuations in the light emitted by the lamp, then the increase in the candle-power produced by an increase in voltage must be small. Table III. gives the percentage change in candle-power produced by a 1 per cent. change in volts.

TABLE III.

Type of Lamp.	C.P.
Ordinary carbon	6·5 per cent.
Metallized „	4·6 „
Tantalum	4·6 „
Osram	4·0 „
Just-Wolfram	3·9 „
Zircon	4·0 „

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From this Table it is clear that the carbon filament lamp is the worst for use on a fluctuating pressure, whilst the Osram, Just-Wolfram, and Zircon are the best. If, however, an alternating current of constant effective value be supplied to any filament lamp, owing to the fact that the current flowing through the lamp passes through zero value twice in each cycle, the light emitted by the lamp must fluctuate also, even though the number of cycles per second be as high as fifty. The question then arises—Is this fluctuation serious? Experiments have been conducted to test this point in the following way :—A disc (see *Fig.* 6) was fitted on to the shaft of an alternator which supplied the alternating current, having as many radial slits in it as the alternator had poles. If a lamp fed by the

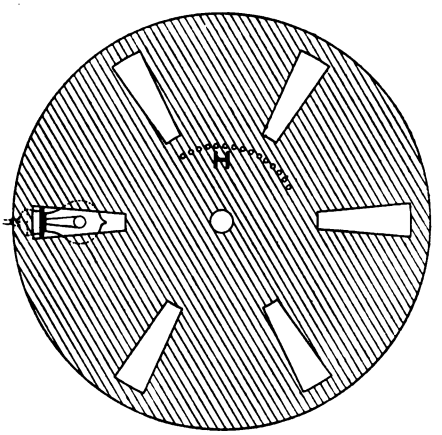

FIG. 6.—*Disc used in Experiments on Instantaneous Variation of Candle-Power.*

alternating current from this machine was examined through these slits while the alternator was running, the light emitted by the lamp which passed through the slit to the eye of the observer was the light corresponding always to the same instantaneous strength of the alternating current. Now if the disc was displaced through a given angle on the shaft of the alternator and the lamp again examined, the light emitted would now correspond to another instantaneous current strength. The results obtained by this mode of experimenting are given in *Fig.* 7. These curves show that though the flickering of the lamp is small at a frequency of 60 cycles per second, yet it is quite appreciable; and, of course, for lower frequencies the effect would be more marked.

I have collected in Table IV. the efficiencies of a number of these metallic filament lamps, and included some figures relating to arcs for purposes of comparison.

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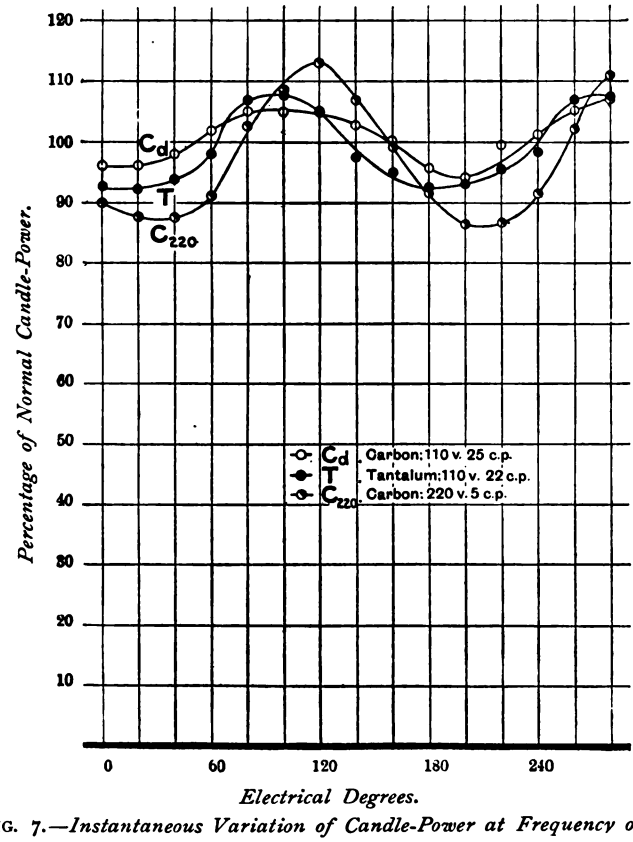

FIG. 7.—*Instantaneous Variation of Candle-Power at Frequency of* 60.

TABLE IV.—*Efficiency of Electric Lamps.*

	Watts per C.P.	C.P. per Watt.
Carbon	3·5	0·29
Metallized Carbon	2·7	0·37
Nernst	2·1	0·48
Tantalum	1·9	0·53
Tungsten	1·3	0·77
Helion	1·1	0·90
Arc (open)	1·0	1·0
Arc "Excello" (globe on)	0·4	2·5
Arc "Excello" (globe off)	0·26	3·8

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The first column of figures in the table marked watts per candle gives what is commercially called the "efficiency" of the lamp, but really it should be called the *inefficiency* of the lamp. The last column gives the *real efficiency*, that is, the candle-power obtained per watt. From these figures it will be seen that one can reduce the amount paid for electric energy used in lamps to about one-third of that previously used for the same candle-power by the use of certain metallic filament lamps. And though the cost of the metal filament lamp is much greater than that of the carbon lamp, yet it is financially quite sound to pay from three to four times the price for a lamp, if by so doing, the current bill be reduced to a third, for in a carbon lamp about 13 to 15 times the cost of the lamp is paid for current used by the lamp during its lifetime.

In concluding, I will place before you (Table V.) some approximate figures relating to filament lamps, and would draw your attention to the present limitation of the voltage for which these metal filament lamps are made, *i.e.*, about 130 volts as a maximum, and also to the fact that the smallest candle-power obtainable is rather large.

TABLE V.—*Approximate Values.*

Name of Lamp.	Watts per C.P.	Useful Life in Hours.	Max. Voltage.	Min. C.P.	Price.
Ordinary Carbon ...	3·5	1000·	240·	5·	1s.
High Efficiency ..	3·0	500·	220·	25·	2s. 3d.
Metallized Carbon ...	2·7	1000·	130·	16·	1s. 9d.
Nernst...	2·0	Uncertain	250·	25·	4s. to 16s.
Tantalum	1·9	1000·	130·	23·	2s. 9d.
Osram	1·3	1000·	120·	28·	3s. 3d.
"Z"	1·25	1000·	120·	28·	—
Helion	1·0	over 1000	110·	30·	—

NOTE.—Both Osram and "Z" lamps have been made experimentally for circuits of 200 volts, but as yet are not commercially obtainable.

An examination of these results leads us to the conclusion that although the efficiency obtainable nowadays is from three to four times that which could be obtained ten years ago, yet there is plenty of room for further scientific research in the laboratory, as well as for improvement of commercial processes.

Finally, let us hope that keenness of competition will cause us to persevere until a really good and healthy light may not be considered in any way a luxury, but may be within the reach of all.

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ELECTRICITY SUPPLY.

By CAPT. R. C. HAMMOND, R.E.

A SHORT time ago, through the courtesy of the chief engineer of the Bournemouth and Poole Electricity Supply Company, I was afforded an excellent opportunity of visiting one of the largest electric supply works in the South of England. The following notes made at the time are intended to give a short description of the work I saw, and incomplete as they admittedly are I hope they may yet prove of use to officers interested in the subject.

The Bournemouth and Poole Electricity Supply Company supplies electric light for Poole, Branksome, Bournemouth, Boscombe, Southbourne, and Christchurch; also power for a considerable portion of the Bournemouth Electric Tram system.

The authorised area of supply is 54 square miles, with a population of 110,000, although the actual number of consumers is 3,500.

The annual output is 3,000,000 B.T. units.

Maximum load 2,000 k.w.

45 miles of high-tension mains.

120 „ „ distributing „

The main works are situated in the Bourne Valley about $2\frac{1}{4}$ miles from the centre of the town of Bournemouth. The Bourne, from which the town derives its name, is an insignificant stream by no means capable in itself of supplying the large amount of water required for the Company's works, and the additional sources of supply are therefore utilised.

Some of the feed water required for the boilers, is pumped from a well 269 ft. deep. The water is lifted by compressed air supplied by a quadruplex compressor driven by an electric motor; the pressure maintained being 42 lbs. per square inch and the rate of discharge about 4,000 gallons per hour. The diameter of the bore hole is 7 inches. The water is distributed to storage tanks by a centrifugal pump driven by an electric motor which is automatically started by a float switch.

Even then the combined supply of water thus obtainable from the Bourne and the well is insufficient for the normal requirements of the works. More water is certainly obtainable from the Water Company's mains, but it is so hard that it has to be softened before it is fit for use in the boilers, and the expense of using it in large quantities

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is almost prohibitive. It is therefore necessary on the score of economy to collect the condensed water from the engines and to purify it so that it may be again used in the boilers. This is done by treating it with a mixture of the following solutions; alumina ferric, carbonate of soda, hard water. This causes the oil to coagulate and be retained by the sand filters through which the mixture is passed, the purified water then passing through to feed tanks.

The Boiler House contains six boilers of the Babcock and Wilcox water-tube type capable of evaporating 120,000 lbs. water in the hour. Only small coal is used in the furnaces: it is conveyed by a bucket conveyor to overhead bunkers in the boiler house, the bunkers containing about 1,000 tons. The coal is drawn from the bunkers by automatic weighing shoots and miniature hoppers, and the furnaces are fed by moving chain grate automatic stokers. The cinders are removed by the conveyor as it passes back under the boiler house. The draught is effected by exhaust fans, so as to save building high chimneys. The flue gases are analysed in an automatic CO_2 recorder, a valuable aid to the economical control of the furnace, and these gases are afterwards utilised for heating the feed water.

The Engine Room.—To provide traction power for the tramways; a continuous current is employed at a pressure of 550 volts, capacity 400 k.w. For the electric light system and small power users, an alternating current is employed, potential 2,200 volts, total capacity 3,400 k.w.

The continuous current 'traction' set.—This has its own condenser, and the cooling water is either obtained from the Bourne brook or cooled by being pumped up on 'cooling towers.' The engine is a vertical fully-enclosed compound one, running at 400 revolutions per minute. The dynamo is 6 pole 550 volts, and can be run either as compound or shunt wound.

The alternating 'lighting' sets.—In the daytime, when the load is light, a self-contained set consisting of engine, alternator and exciter, all on one shaft, is sufficient.

For night work, with full load, five larger sets are brought into use, three of 400 k.w. each, and two of 1,000 k.w. each. These are separately excited from a small direct-current machine at low pressure. For each of the three smaller sets there are two vertical enclosed compound tandem engines running at 212 revolutions, whilst the two larger sets are driven by triple-expansion engines running at 250 revolutions. The alternators generate 2,000 volts at 100 periods per second. Steam is supplied to the engines at 150 lbs. pressure and heated to 450° F., *i.e.* about 100° super heat; this, it is found, increases economy and reduces leakages. The machines are perfectly balanced and run so smoothly that it is difficult for the onlooker to realise that each of these large dynamos represents a mass of 30 tons revolving 250 times in the minute. Needless to say,

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with this class of machinery, the most stringent precautions are taken to exclude anything in the nature of grit or dirt from the engine room.

The switch-boards are situated in a raised gallery running along one side of the engine room. The high-tension switch-boards are of cellular pattern, with all conductors behind glass screens. No unauthorised person is allowed in this part of the establishment. Underneath is a second gallery whence the cables radiate and which also contains appliances for regulating resistance. In connection with the 'traction' installation there is an automatic booster for regulating charge and discharge from a battery of accumulators. In accordance with Board of Trade regulations no precaution or device is neglected for ensuring the safety of employés, and the only fatal accident which has occurred was due to the victim having been guilty of a flagrant breach of orders.

The Distributing System.—With the exception of the two outlying sub-districts of Poole and Christchurch, the method of distribution is as follows:—The alternating current from Bourne Valley is conducted by five high-tension concentric feeders to the chief distributing centre situated in Bournemouth Central, and from there it is further distributed by high-tension cables to transformer chambers all over the district. This process of distribution necessitates the introduction of several high-tension inter-connecting chambers at various points between the distributing centre and the transformer chambers.

The pressures, in the different branches, are regulated at the distributing centre by means of booster transformers, these being static machines regulated by hand.

The transformer chamber is used for transforming the high-tension current into a low-tension current for delivery to consumers. The current passes to the transformer, thence to a maximum indicator, and thence to a distributing box, whence it is taken up by triple concentric distributing cables and delivered to consumers on the 3-wire system at a pressure of 100 or 200 volts. The pressure of supply is at 200 volts in all the more recently supplied areas, the lower pressure of 100 volts occurring only in the older parts of the system.

At the Head Offices of the Company may be seen a most interesting display of lamps, photometers, meters, etc., but as Lieut. Lloyd Owen has recently given the readers of the *R.E. Journal* a good description of the latest types of filament lamps I do not propose to describe them.

To ascertain the illuminating power of any lamp it is necessary to compare it with a standard lamp under the same voltage. This can be done by an instrument known as a photometer. The standard lamp is placed at a fixed distance from the photometer head; the new

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lamp is then approached to the photometer head from the opposite direction until the latter records that it is receiving an equal intensity of light from each lamp. The candle-power of the new lamp can then be read off on the graduated scale. The two principal types of photometer are the 'flicker' and the 'stationary' type. In the former, so long as the light received was not the same from each lamp, a 'flickering' was observable whilst watching an illuminated segment rotating in the centre of the instrument; whilst in the latter type one side of a wedge-shaped surface would appear less brilliantly illuminated than the other side. The process of comparison involved adjusting the distance of the unknown lamp until the flickering in the first case or the dividing line of shadow in the second were no longer observable. As regards the relative merits of these two types of photometer, it is found that when the lights to be compared are of different colour the flicker photometer is the most sensitive; but with lights of the same colour the flicker photometer is not so good as the best stationary photometer such as Bunsen's.

Lastly as regards meters; these are mostly on the motor principle, whereby the current in its passage rotates a disc connected to the recording mechanism. In other meters the current in passing through a liquid liberates gases, and their volume when measured forms a record of the amount of current which has passed. And, finally, there is the 'shilling-in-the-slot' meter. Any ordinary type of motor meter can have attached to it a mechanism by which a small switch is opened at a moment defined by the number of revolutions that the meter disc has made. The mechanism is set by the insertion of coins in a slot, and any number of coins up to 25 may be inserted at one time. The switch will then be open until current equivalent to the value of all these coins has been consumed.

In another type of 'shilling-in-the-slot' meter a copper ribbon is wound down into a chemical solution, a fixed amount for each shilling inserted. The passage of current through the copper and solution erodes the copper, so that, by the time current equivalent to the value of the coins inserted has passed, the submerged portion of copper strip is entirely consumed, and so the circuit is broken. This latter type can only be used on a continuous current supply and the amount of current thus obtainable for 1s. (some 1·7 units) is sufficient to light one ordinary carbon filament lamp of 8 c.p. for 56 hours.

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THE SCHOOL OF ESTIMATING AND CONSTRUCTION AT THE S.M.E.

By LIEUT.-COL. B. R. WARD, R.E.

ON the 15th September, 1825, an order of the Master-General and Board of Ordnance was published directing that a course of Practical Architecture should be instituted at the Royal Engineer Establishment at Chatham.

Lieut.-Colonel Pasley, as Director of the Establishment, shortly afterwards got out an *Outline of a Course of Practical Architecture, compiled for the Use of the Junior Officers of the Royal Engineers.*

This was one of the most valuable of Pasley's handbooks, and has had a longer life as a text-book than any other S.M.E. publication, having been subsequently reprinted in 1862.

The preface to the book is here reproduced :—

"His Grace the Duke of Wellington, Master-General of the Ordnance, having been pleased to direct that Practical Architecture should in future form part of the course of study of the junior officers of Engineers, and having approved of General Mann's proposition that it should be conducted at this Establishment, and that Mr. Robert Howe, Clerk of Works of the Establishment, whose mechanical skill and ingenuity, as well as his knowledge of the practical details of architecture, are well known to the Corps, should be employed to assist in carrying on this branch of duty as Professor of Practical Architecture, I have been induced, as Director of the Establishment, and responsible for the general execution of all the duties, to give my attention to this subject, and to endeavour, by the able assistance of Mr. Howe, to bring the proposed course of Practical Architecture to a system. I have, accordingly, commenced the following work, which I have entitled an *Outline,* etc., because it is not my intention to write a complete course, even if I were qualified for so doing. The most difficult branches of Practical Architecture have for some years past been treated of in this country by very able writers, amongst whom Mr. Peter Nicholson deserves the praise of having been the first to show so useful an example, which has since been followed by Mr. Tredgold and others. But there are several parts of this important subject which those writers have scarcely noticed, probably from the circumstance of their being generally known to all

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persons regularly brought up to the profession of architecture or to the mechanical trades connected therewith.

"My object has been to endeavour to fill up those deficiencies, an attempt which, if successful, may be useful to the junior officers of the Corps, who are often sent to the British Colonies soon after they enter His Majesty's Service, and are there required to perform duties analogous to those of architects or civil engineers, without having had any previous opportunity of acquiring a practical knowledge of the details of those duties; and where, although they will derive considerable assistance from a good collection of the books before alluded to, they will still find themselves at a loss in respect to many particulars of considerable importance, which are not sufficiently explained.

"In the course of this undertaking I have already derived considerable assistance from the liberal communications and information afforded me by some of the most eminent civil engineers and builders of this country and the persons in their employment, and I hope to derive equal benefit from the same source in the remainder of my work. A series of plates connected with it has been drawn by Mr. Howe, but, according to the custom adopted in my former elementary writings, I have generally preferred introducing figures extracted from those plates into the body of the work, opposite to those parts of the subject which they are intended to illustrate.

"Having, from circumstances, had less experience in those matters which form the subject of this work than most officers of the same standing in the Corps, if my brother officers will favour me with any remarks which they may consider useful I will be much obliged to them, as a few copies only have now been lithographed, under an expectation of improving the work in a second impression, after more information shall gradually have been collected.

"I have heard it remarked by some gentlemen in civil life that it seems almost too much to expect the same individuals to combine the habits and feelings of the military life with the laborious pursuits of men of business. In exacting both from the Corps of Royal Engineers the Government of this country appear, however, to have acted more wisely than if they had confined the Corps to military duties solely. The same kind of talent and knowledge that render an Engineer officer capable of forming the project of military works, and of arranging and directing great masses of workmen in a siege, or in fortifying the position of an army in time of war, by a very little more study will enable him to superintend the construction of public works of equal importance in time of peace; and if the Government did not find employment of that description, such as the superintendence of public buildings, barracks, etc., and the execution of other public works for the officers of the Corps of Royal Engineers and the soldiers under their orders, it would be necessary in time of

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peace either to employ them in the common routine of infantry duties or to disband them. There is no other alternative, for their being allowed to remain idle is out of the question.

"By combining science and industry with the activity, zeal, and spirit of the military character, and by considering none of the multifarious duties that he may be required to perform as a drudgery, since they are all equally useful to his country,* the young officer of Engineers has it in his power not only to establish a reputation for himself, but to contribute towards maintaining the fame of his Corps as one no less useful in peace than distinguished in war."

The last sentences of the foregoing preface, illuminated and framed, now hang in a place of honour in the Construction School, in order that Pasley's splendid ideal regarding the combination of science, industry, and the soldierly spirit may be placed before successive generations of R.E. officers while going through the course of Construction and Estimating.

The following is a complete list of the various officers who have held the appointment of Instructor or Assistant Instructor in this branch of study :—

INSTRUCTORS IN THE ARCHITECTURAL COURSE.

Mr. Robert Howe	1825-54
Mr. G. R. Brock	1854-66
Capt. T. B. Collinson	1861-66

INSTRUCTORS IN ESTIMATING AND CONSTRUCTION.

Capt. and Brevet Major H. Wray ...	1866-74
Major P. G. L. Smith	1874-79
„ H. C. Seddon	1879-85
„ A. J. C. Cunningham	1885-90
„ E. C. S. Moore	1890-93
„ G. K. Scott-Moncrieff	1893-98
„ J. Winn	1898-04
„ E. M. Paul	1904-

ASSISTANT INSTRUCTORS.

2nd Capt. H. C. Seddon	1867-72
Capt. W. R. Slacke	1872-75
„ J. T. Marsh	1875-79
„ A. G. Clayton	1879-84

* In respect to those details of duty alluded to, which are the most uninviting, such as the superintendence and measurement of barrack repairs, the receipt of materials, etc., the young officers of Engineers will do well to recollect that upon the strict and faithful execution of their orders when so employed the saving of thousands to the public may depend.

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Capt.	C. L. Young	1884-88
„	W. H. Turton	1888-93
Lieut.	E. M. Paul	1893-98
„	J. Lang-Hyde	1895-00
„	J. B. MacGeorge	1898-02
„	S. G. Faber	1900-05
„	E. E. B. Wilson, D.S.O.	1902-06
„	G. J. P. Goodwin	1905-
„	P. O. G. Usborne	1905-07
Capt.	E. N. Stockley	1906-
„	A. M. Henniker	1906-
Lieut.	J. G. Fleming	1907-

Pasley's chief title to fame in connection with his work in the Architectural School is based on his discovery of the hydraulic properties of cement manufactured from chalk and Medway mud, now universally known as Portland cement. From a constructional point of view, the invention of Portland cement ranks probably, with Bessemer's improvements in steel manufacture, and the use of reinforced concrete, as one of the three most important inventions of the nineteenth century. To this day the greater part of the Portland cement made in England is manufactured on the banks of the Thames and the Medway.

The course, as originally framed by Colonel Pasley, although termed architectural, was confined for the most part to builder's work and timber structures. It was based on Tredgold's and other manuals of that time, and instruction in estimating and measuring up work was given in the office of the C.R.E.

Capt. Collinson,* 1861–1866, continued on much the same lines.

Major Wray, 1866–1874, introduced a more particular study of Applied Mechanics, and in general carried out the course on more scientific lines. He brought out a text-book entitled *Instruction in Construction* in 1872. In this book the subject was treated from a mathematical standpoint, and calculations for plate and lattice girders, iron roof trusses, masonry retaining walls, reservoir dams, etc., were introduced, in order to keep pace with the general advance in engineering science and the largely increased use of iron, due to improved manufacture. This book was successively revised by Majors Percy Smith, Seddon, and Cunningham, and was used as a handbook at the S.M.E. until 1893.

Major-General E. Renouard James, in an obituary notice of Lieut.-General H. Wray in the *R.E. Journal* of the 1st June, 1900, writes as follows of the work done in the Construction School at Chatham

* Capt. Collinson was one of the R.E. officers who was employed on the Great Exhibition of 1851 under Colonel Sir William Reid, K.C.B., R.E.

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when Wray was appointed Instructor in Estimating and Construction on the 1st June, 1866 :—

"The newly-joined Engineer officer came to Chatham fairly grounded in mathematics and geometry; he could make some sort of a military survey of ground; draw and read plans; and (if ever so little artistic) sketch a landscape intelligently enough to illustrate a report; he had also learnt the elements of mechanics, mineralogy, and chemistry. His intellect, therefore, was in a properly receptive state to enable him to learn how to build a house, construct a bridge or a roof, or lay out a line of railway. Yet, the Chatham course in the arts of construction, as conceived by the authorities at the time under the advice of the estimable Mr. Brock, left the young officer exactly where he began—if, indeed, he did not forget much he had already learnt—and the average man left Chatham incapable of designing or superintending the erection of the simplest work. There were notable exceptions, of course, as, for instance, Wray himself, Fowke, H. Y. D. Scott, Seddon, Colin Scott-Moncrieff, and others, but the assertion is correct in the main. Our course consisted of little beyond colouring a series of outline plans, and the official idea seemed to be that this practice would have the effect of forcing the information these contained into our intellectual pores in some such manner as brine is absorbed in the pickling of pork. But, as the importance of neatness was much impressed on us, we learnt little more than the art of putting on flat washes of red and blue. No attempt was made to teach us how to apply statics and dynamics to the art of designing. We had no instruction as to the materials we should use in different countries; the estimating and taking out quantities for work ended by the mere copying of one page of figures. Can it be wondered at that many an one of us, finding the need of such knowledge in after life, had to grind it out for himself far away from libraries, with the humiliating feeling of dependence on clerks of works in carrying on works in his charge?

"Wray changed all this. On no account whatever should an officer be employed to copy plans! The proper use of an officer—in his view—was not this; and he merely required to be satisfied that sufficient technical knowledge of plans had been acquired at Woolwich, and in future all copying work ought to be done by subordinates. It should be the duty of the officer to supply the draft design, but it would be sufficient if this were made in pencil outline, provided that every essential dimension was figured. The stability of arches, the thicknesses of abutments, the scantlings of timber, the details of girders, the diameters of pipes, and, in fact, all matters involving calculations of strength, tension, compression, and so on, the officer must be personally responsible for. Directions should be given as to the materials to be used, and it would be sufficient at first for the officer to make an approximate estimate of cost. He should

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give rough sketches of the decorative details, artistic as far as he could make them so without loss of time. From the officer's notes the draughtsman and quantity clerk should make careful plots and a first estimate; and the officer, watching the working out of his ideas, should direct the necessary amendments as the work proceeded. It might become necessary to have the plans and estimates made more than once before elaborate drawings could be finished; but, even if this were the case, the pay of the draughtsman and quantity clerk would be well worth the saving in cost which would accrue by sparing the valuable time of the officer.

"Such were Wray's principles. They took concrete form in his well-known book on *The Theory and Practice of Construction*, the first edition of which was published in 1872. Sir J. Lintorn Simmons, Commandant of the School of Military Engineering, seconded Wray's efforts thoroughly, and in a letter dated December 27th, 1872, referred to the book 'as a lasting proof of the great benefit conferred, not only on the Corps, but on the public service.' By the examples given of the various constructional problems met with by Engineers, and by the clearness with which theory was reduced to practice in their solution, a long-felt want was supplied; and the book was at once accepted by the profession of civil engineers, as much as by our officers, as the best manual extant. The information it contained and the formulæ have been extended and applied to new inventions by Seddon and others; but the value of the original work remains undisputed, and it is acknowledged to be a pattern of what such a book should be.

"Wray remained at Chatham nearly eight years, during which period (as the Corps records show) nearly 300 second lieutenants benefited by his instruction. The principles he laid down are still in force, and (as it may be asserted that the great majority of our officers on the effective list have been trained on his system) their adoption has been of incalculable advantage to the entire Corps. Such a monument of the work of one man is the noblest which could be raised in his memory, and it might be said of him proudly:

'Si quœris monumentum, circumspice.'" *

A short obituary notice in the *R.E. Journal* of the 1st June, 1893, describes Major Percy Smith's work in the following words:—"He was a most painstaking, conscientious worker, always striving to do his very best, and, at the same time, unusually modest and retiring.

"The three volumes of *Notes on Building Construction* published anonymously by Messrs. Rivington for the use of the Science and Art Schools in connection with South Kensington are a lasting monument to his patient industry and capacity for mastering details. It is far

* *Corps Archæologia*, No. 3, pp. 122—125.

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and away the best book of the kind which has ever been brought out, and many of his friends greatly regretted that the author's name should remain unknown to the thousands of teachers and students who have profited by it. A fourth volume on *Theory of Construction* was published in 1891."

In Major Seddon's time, 1879–1885, the practical part of the course was strengthened by his *Notes on the Building Trades and Building Construction*, first published in 1873, and by Slacke's *Notes on Drainage*, the first English text-book on the subject, published in 1875. Various useful pamphlets were also got out about this time by Capts. Marsh, Clayton, and Young, on doors, windows, stairs, roofs, etc.

Major Cunningham (1885–1890) brought with him Indian experience and great mathematical knowledge. At this period the principal schemes worked out by officers under instruction were designs for barracks and a plate girder, with some subsidiary schemes involving walls, roofs, stairs, etc.

Major E. C. S. Moore (1890-93) developed the study of sanitary engineering, and brought out a text-book entitled *Sanitary Engineering Notes*, and another entitled *Notes on Gas*. The former, under the title *Sanitary Engineering*, was enlarged by Colonel Moore, and re-published in 1898 by Batsford. It is recognized as a standard work on the subject.

Major Scott-Moncrieff (1893-98) introduced into the course a good deal of general engineering, including the study of railways, harbour works, and reservoirs. He wrote two text-books, *The Water Supply of Barracks and Cantonments* and *Principles of Structural Design*. He may be said to have given a practical trend to the course in the working out of schemes and engineering problems.

Major Winn (1898–1904) maintained the up-to-date character of the course, and introduced the study of reinforced concrete. His *Notes on Steel Concrete*, the first book on the subject published in English, is still in use.

The present policy of the Construction School is to keep in close touch with modern engineering practice, to familiarize officers with the application of the principles of applied mechanics and architecture by frequent practice in designing various structures in connection with military buildings, and in the preparation of schemes for the water supply and sanitation of cantonments both at home and abroad. Manuals dealing with various classes of structures are being revised and prepared to this end.

In the winter of 1905 an "Advanced Course" of three months' instruction was instituted in addition to the six months' S.M.E. course of instruction, hitherto authorized, but not always completed in the case of every officer.

This procedure still obtains, the object of the course being to give

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officers such professional information as will fully equip them for their duties as divisional officers at home and in the colonies.

The great advance of late years in engineering science has somewhat changed the character and scope of the course of "Estimating and Construction," so that some more comprehensive title, such as "Civil Engineering and Design," would better designate what is dealt with in the course as at present constituted.

The training of N.C.O.'s as Military Foremen of Works forms an important section of the School. Some twenty-two or so pass out annually, and after a probationary period obtain the rank of Staff Sergeant Military Foreman of Works. Their course lasts eleven months. This includes short furloughs and instruction in survey (one month), electric bell-fitting (fifteen days), the remainder of the time being devoted to instruction in building work, sanitation, water supply, estimating and R.E. services, and practical inspection of works in progress. Of recent years the educational qualifications have been increased so as to secure the best men, and raise the standard of technical attainments and knowledge.

N.C.O.'s, men, and buglers are also trained as architectural draughtsmen; this course lasts 150 days, and is a very comprehensive one.

Quite recently it has been decided that all N.C.O.'s proceeding to India shall receive a training as draughtsmen and in engineering subjects, which will fit them for their duties with the Corps of Indian Sappers and Miners, and Military Works Services. The course lasts about one and a-half months.

The best known, as well as the earliest established of the S.M.E. prizes, is given for proficiency in the Construction course. This is the Fowke Medal, which was instituted to effect a memorial to Capt. Francis Fowke, R.E., who died in London on 4th December, 1865, and who was undoubtedly the most distinguished architect that the Corps ever produced, and consequently a short *resumé* of his career may not be out of place in this article.

He obtained his first commission in 1842, but it was not until 1857, when he was appointed to the staff of the Science and Art Department as an Inspector, that he was given an opportunity of displaying his talents in this particular direction. At that time the offices of the Science and Art Department were located in Marlborough House. On the transfer of the Department to South Kensington, Fowke was charged with the superintendence of the buildings there. While engaged in this work he built picture galleries to receive the Sheepshank, Vernon, and Turner National collections. As architect and engineer of the Science and Art Department he designed the Museum of Science and Art at Edinburgh, and improved and enlarged the Dublin National Gallery. He planned the buildings for the International Exhibition of 1862, and the exact proportions

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of the picture galleries and the system of lighting were adopted afterwards in France at the Paris Exhibition of 1867.

In 1864 an open competition was held of designs for buildings to be erected on the site of the 1862 exhibition. Fowke, who did not make up his mind to compete until seven weeks before the drawings had to be sent in, was unanimously awarded the first premium.

At this time, and until his death in the following year, he was engaged in the erection of the present South Kensington Natural History Museum.

In the large entrance court—a quadrangle of about 100 feet span—he glazed over the entire roof without a single support, in order that the objects exhibited might not be interfered with by columns.

With the assistance of Mr. Godfrey Sykes, the decorative artist (*Dict. Nat. Biog.*, Vol. LV., p. 256), Fowke was working at the terra-cotta exterior decorations of the building, and at the highly-ornamented columns of the same material, at the time of his death, in December 1865.

Sir Henry Cole, one of Fowke's colleagues in the Science and Art Department, spoke thus of him at a meeting of the Society of Arts:—

"I firmly believe that the arts of construction in this country have sustained a great loss by Capt. Fowke's death. At this period, when art is so transitional, and science is making so many discoveries, and men's minds are seething with inventions, when the use of new materials is being constantly manifested, and the new adaptation of old materials is constantly entered upon, England has lost a man who felt the spirit of his age, and was daring enough to venture beyond the beaten path of conventionalism. Capt. Fowke, to my mind, was solving the problem of the decorative use of iron, and, by appreciating the spirit both of the Gothic and Renaissance architects, was on the threshold of introducing a novel style of architecture, when, alas! death, at the early age of 42 years, has cut short his promising career."*

The prize was instituted at a Corps Meeting in 1866. The Commandant of the S.M.E. submits annually to the Council of the R.E. Institute the names of one or more young officers who have lately passed through the School, and whom he considers to have specially distinguished themselves in the School of Construction, and a Silver Medal is duly awarded. A similar medal but in bronze is given annually to the non-commissioned officer who has most distinguished himself in the same subjects whilst under instruction in the Military Foremen of Works Class.

The following is a complete list of officers and N.C.O.'s who have gained the Fowke Medal since the institution of the medal in 1871:—

* *R.E. Professional Papers*, Vol. XV., 1866, p. 15.

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OFFICERS.

Lieut.	M. F. Ommanney	1872
„	C. H. P. Christie	1873
„	H. E. McCallum	1874
„	H. E. Rawson	1875
„	M. H. P. R. Sankey	1876
„	A. H. Mason	1877
„	J. H. Cowan	1878
„	A. G. Thomson	1879
„	J. A. Tanner	1880
„	E. H. Hemming	1882
„	W. A. J. O'Meara	1884
„	C. H. Enthoven	1886
„	P. B. Molesworth	1887
„	T. Fraser	1888
2nd Lieut.	C. H. H. Nugent	1889
„	W. E. R. Dickson	1890
„	N. J. Hopkins	1891
„	A. G. Stevenson	1892
„	W. H. Jones	1893
„	C. F. Anderson	1894
„	A. A. Crookshank	1895
„	H. O. Mance	1896
„	H. de L. Pollard-Lowsley ...	1897
„	P. S. Greig	1898
„	C. M. Browne	1899
„	C. F. Birney	1900
„	E. W. C. Sandes	1901
„	E. de L. Young	1902
„	H. T. Morshead	1903
„	A. H. L. Mount	1904
„	L. V. Bond	1905
„	C. E. Colbeck	
„	L. E. Becher	1906
„	R. Hamilton	1907

NON-COMMISSIONED OFFICERS AND SAPPERS.

Sergt.	T. Laman	1871
Corpl.	J. Sutherland	1872
„	L. Boyce	1873
Sergt.	J. Hussey	1874
2nd Corpl.	W. Baker	1875
Corpl.	G. Michie	1876
Sapper	J. Fraser	1877
Corpl.	A. Jones	1878

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Sergt. F. Bowling	1879
Corpl. J. McLeod	1880
2nd Corpl. S. McKetterick	1881
Corpl. A. Cox	1882
2nd Corpl. C. Lloyd	1883
Corpl. W. Sherman	1884
„ G. Chimes	1885
Sergt. A. McIntyre	1886
Corpl. W. Dallas	1887
„ E. Cubbon	1888
2nd Corpl. J. Bullock	1889
„ T. Barnett	1890
Corpl. T. Smith	1891
„ F. Palmer	1892
„ R. Smith	1893
„ W. Cooper	1894
„ T. Welsh	1895
2nd Corpl. J. Harkness	1896
Corpl. G. Polkinghorne	1897
2nd Corpl. H. Lawford	1898
„ R. Gingell	1899
Corpl. B. Salter	1900
2nd Corpl. H. Peacock	1901
Corpl. A. Parsons	1902
„ H. Parke	1903
„ J. Boyd	1904
2nd Corpl. E. A. Wilmshurst	1905
„ A. W. Reynolds	1906
„ H. Osborn	1907

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MEMOIR.

General Sir Edward Charles Sparshott Williams, K.C.I.E., Colonel Commandant, Royal (late Bengal) Engineers.

To the veterans of the Royal (late Bengal) Engineers, to the many officers of the Corps who went to serve in India soon after separate recruitment for the Indian Corps had ceased, and to all concerned with the Government of India from the days of Lord Lawrence and Lord Mayo to the present time, the name of General Sir Edward Williams will always be closely and honourably connected with the great State Railways of India. Indeed, to their creation and administration, in close and intimate association with his eminent chief, General Sir Richard Strachey, G.C.S.I., R.E., he devoted the more mature years of his service, both in India itself and subsequently at the India Office in London.

Proud of his Corps, proud of the great part it had played both in the field and in the development of Indian resources by the successive stages of roads, irrigation works, and railways, Williams in the early years of his service had a full share of the manifold duties which in those days, even more than now, fell in the way of and were the opportunities of the energetic young Sapper officer, and his brilliant abilities and remarkable capacity for orderly detail carried him successfully through a succession of new and difficult charges, from each of which he emerged with increased repute.

An interesting summary of Williams' services, which appeared in *The Times* on the 3rd October, 1907, is here reproduced in full.

"General Sir Edward Charles Sparshott Williams was one of the dwindling band of Indian veterans who were sufficiently experienced at the time of the Mutiny to hold positions of considerable importance and responsibility. Educated at the Royal Naval School, New Cross, and at Addiscombe, he was commissioned to the Bengal Engineers in 1848. When still scarcely out of his teens he was Adjutant of the Engineer Corps in Fort William, Calcutta, and concurrently was studying the machinery and equipment of the Calcutta Mint. For a short time he was extra Assistant Secretary to the Military Board—an authority which came into considerable conflict with Lord Dalhousie, and subsequently underwent substantial reform. It was in the capacity of Adjutant of Engineers that the young officer saw his first and only war service. This was in Pegu

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in 1852, when he was present at the bombardment and capture of Martaban and Rangoon (where he was slightly wounded), the capture of Prome, and the occupation of Meaday. He was mentioned in despatches for gallant conduct, and was awarded the medal with clasp. He remained in Burma to superintend the topographical survey of Pegu, and on returning to Calcutta was made Principal of the Civil Engineering College. During the Mutiny he was Under-Secretary to Government in the Public Works Department. In 1860 he left Calcutta to undertake the principalship of the Thomason Engineering College at Rurki, the chief institution of its kind in India. He returned to headquarters, however, in 1863 as Under-Secretary of the Public Works Department, and this position he held for six busy years, the department being then actively engaged in the development of railways and other communications which had been shown to be so desirable by the events of 1857. But Williams was a strenuous worker, and not only did he join the Bengal Sanitary Commission, but for twelve months held charge of the office of Inspector-General of Forests. Next came a transfer to Bombay as Mint Master and Commissioner of Paper Currency. He returned to headquarters in 1867 as Deputy-Secretary of the Railway Branch of the Public Works Department, a position he continued to hold till his retirement from India in 1880, save for three years' interval as Director of State Railways. His wide and varied experiences in the public service were naturally utilized by the Secretary of State, who appointed him in March, 1880, Deputy-Director of Indian Railway Companies. Twelve years later Lord Cross advanced him to the headship of this branch of the Public Works secretariat at the India Office, and a few months afterwards he was promoted from the Companionship of the Indian Empire, conferred upon him in 1878, to a Knight Commandership. Sir Edward Williams retired from the India Office in 1897, with the proud record of well nigh half a century of service of the Indian administration in manifold capacities, all in turn admirably filled. Sir Edward Williams was twice married, his first wife dying in 1857, and his second in 1872."

Of his early school days I am unable to add further particulars, but at Addiscombe Williams was head of his term, and on getting his commission in the Bengal Engineers in 1848 was the first recipient of the Pollock Medal then founded, and from that time the hall-mark of the most distinguished officer of his term. When Addiscombe was closed in 1861, the Pollock Medal was transferred to Woolwich, and in 1885 it was won by his only son, now Major H. B. Williams, D.S.O., R.E.

Shortly after his arrival in India in 1851 Williams was appointed Adjutant of the Corps in Calcutta, and on the despatch of the Burma Expedition in 1852 he accompanied it as Adjutant of Engineers in the Pegu Force.

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A surviving brother officer,* himself the most modest of gallant soldiers, and honoured in later years by the Victoria Cross for subsequent services, has personally told me of Williams' gallantry in the stockade fighting of that expedition, and this same brother officer was the chief actor in the following episode, which an old friend, from whom I quote at greater length below, has cited to me as a remarkable evidence of Williams' intense love of fair play.

"During the first Burmese war young Williams, with several brother officers, who were always foremost in the fray, had rushed a stockade. Williams' sword having broken in the hand-to-hand conflict which ensued, he grappled with a powerful Burman, until a brother officer put an end to the struggle by passing his sword through the body of the Burman as the two wrestled together on the ground. Then Williams rose and indignantly protested against the interference, saying he ought to have been allowed to finish his fight fairly."

Williams was mentioned in despatches, and on the close of the war was appointed to superintend the survey of Pegu. In that capacity he prepared and published for the use of his assistants *Astronomical Memoranda for the Use of Surveyors*, and this is the only published work of his which I can trace, though the records of the Government of India are full of his masterly investigations of railway problems.

Soon after his return from Pegu to India he was appointed Under-Secretary to Government in the Public Works Department, a responsible appointment, which, to his great regret, he was not allowed to leave for active service during the Mutiny of 1857.

Throughout his service he looked forward to further employment on active service, but the early war service in Burma was all he was destined to see.

As will be seen by reference to the outline of his services, it was after a varied experience that Williams, then a major, entered upon the larger duties involved by the adoption in 1869 of a policy of State construction and administration of the railways needed to complete the great system projected by Lord Dalhousie.

Closely associated with General Richard Strachey during the inception of this policy, with which the names of Lord Lawrence and Lord Mayo are inseparably connected, Williams was responsible for the organization of the large department constituted to carry the new policy into effect. The results achieved are the best testimony to his success. A large mileage of railway has been constructed of excellent quality and at moderate cost, and the financial results are satisfactory. There were 5,000 miles of railway in 1870; there are now nearly 30,000.

* Major-General William Salusbury Trevor, V.C., R.E., the brother officer alluded to, died in London on 2nd November, 1907, just after this was written.

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This memoir would be incomplete without a reference to the acute controversy which arose in India and in Parliament over the gauge of the Frontier Railways of the Punjab and Sind, but it will suffice here to say that Williams, who had an official part to fill in this controversy, lived to see with satisfaction the fuller protection of the North Western Frontier of India by a greatly extended system of standard gauge railways.

Of his personal administration of the great staff of Royal Engineers and Civil Engineers who were employed under him in surveying and constructing new railways in all parts of India and Burma, the testimony of one of his trusted lieutenants might be thought partial, and in this matter I am allowed to quote the following extract from a letter from my old and valued friend, Sir Guilford Molesworth, whose official association with the subject of this memoir began early in 1870, and was of the most intimate nature.

Sir Guilford Molesworth writes :—"Coming out as I did to an important appointment in the P.W. Department (Consulting Engineer to the Government of India for State Railways), at a time when the Department had only recently emerged from the condition of an almost 'Close Borough' of Royal Engineers, I naturally (as a Civil Engineer and an interloper) expected to experience some jealousy and friction, but, from first to last, Williams met me in the most cordial and friendly spirit, affording to me most valuable assistance in taking up the duties of my new office, and giving me every help and information in his power. I was greatly impressed with his wide and liberal views, his grasp of the subject, his power of organization, and his ability as an engineer. My official relations with him soon ripened into a warm personal friendship, which only ended with his death.

"It is to be regretted that he did not remain longer in India to assist in maintaining the Indian State Railway policy, which he so ably inaugurated and which was eminently successful, but which has unfortunately been in some measure abandoned, or modified, of late years.

"That which impressed me most in my official connection with him was his extreme conscientiousness, his rectitude, his aversion from anything underhand, his abhorrence of anything like a job, and his love of fair play. He was always most careful not to allow his *esprit de corps* to bias him when a choice had to be made between a Civil and a Royal Engineer."

A devoted public servant, careful of the interests and jealous of the honour of the Government he was proud to serve, dealing with large questions boldly, but critical almost to a fault of details, Sir Edward Williams, both as Director-General of Railways in India, and as Government Director of Railways at the India Office, devoted his

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great abilities to the expansion of the railways, which he held to be so essential to India's peace and progress. Fully alive to their commercial importance, he never forgot that it is by just and firm government, supported by the railway and the telegraph, that we sustain our military position in India, and he claimed, with acceptance by the best authority,* that it was due to the vigorous development of the railway system that "the total military force of India has been diminished rather than increased since 1857."

In his relations with his large staff he was a strong disciplinarian, but always ready to consider and adopt suggestions which stood the test of his keen powers of criticism. Appreciative of ability, he was a considerate and generous chief to all who gave the Government what he thought the best of their service. Himself thoroughly in earnest in all he undertook, he was intolerant of what he thought half-hearted service, and did not hesitate to let the shirker feel his hand.

In private life generous and hospitable, the soul of honour, no less earnest in his religious views than in his service to the State, General Sir Edward Williams, who became Colonel Commandant of the Corps in 1890, lived a full and active life to within a few days of his last illness, and died in London on the 2nd October, 1907, at the good old age of 76, leaving behind him a family of two daughters and the son above mentioned, and also a large circle of warm friends and admirers, who will, I trust, pardon the imperfections that must be found in this short memoir by the present writer, who is proud to have had his friendship.

W. S. S. BISSET.

* General Sir George Chesney, K.C.B., R.E., *Indian Polity*.

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REVIEWS.

NAVIGATING THE AIR.

ESSAYS PUBLISHED BY THE AERO CLUB OF AMERICA.

THIS collection of essays, written by members of the club, will be found of great interest by those who wish to get some idea of the progress recently made in aeronautics.

The *Preface* gives a general account of the formation, objects, etc., of the club.

The *Introduction* describes the principal airships and flying machines from the time of "La France" up to the last efforts of Santos Dumont and Prof. Bell. It is a useful and well-illustrated summary, but does not of course go into much detail.

Chapters I. and II. discuss the machines constructed by the Messrs. Wright. Unfortunately very little information is given about the machines themselves, but the articles are of importance as they give statements by reliable persons which prove clearly that the Messrs. Wright really have performed the feats so frequently reported.

Chapter V. is interesting, as Mr. Ludlow describes his machine and his attempts at flight. There is a good photograph showing the aeroplane in actual flight under the guidance of the inventor.

Chapter VI., by Mr. J. P. Holland, the designer of the submarine boat which bears his name, is perhaps the best in the book. Commencing with some quite pardonable chaff of the various gentlemen who told him that submarines could never be got to work properly, and would be of no use if they did, the author goes on to describe some of his early schemes for flying machines. On page 63 he gives a design of a machine to be worked by muscular energy; but it must be confessed that the success of such an apparatus appears to be very doubtful, as it is not by any means clear that a man has sufficient power to maintain himself in the air. He next goes on to consider the flight of birds, taking the albatross as an example. His calculations for the lifting power do not, however, seem to be very convincing, as he makes out that the lift, when the bird is moving at the rate of 35 miles an hour, with a wing inclination of 6°, is 1·8 lbs. per square foot of wing area, or only about half the amount required. This is clearly incorrect. Any well-shaped surface of wing type, as, for instance, Lilienthal's Table IV. type, will carry nearly $2\frac{1}{2}$ lbs. per square foot under the given conditions, and there is little doubt that the albatross type of wing is much more efficient than that designed by Lilienthal.

With regard to the question of rarefaction of the air over a bird's wing, it is very satisfactory to find that the author gives full credit to Mr. Phillips for the discovery of this important fact. He discusses the machine constructed by this gentleman in detail, and points out its effectiveness.

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The chapter concludes with a description of a machine designed by Mr. Holland himself; it is very much of the Phillips type, with certain alterations, such as a movable aeroplane, etc.

Chapter XIV., "Critical Remarks on Progress," is of interest because Mr. Manley was for a long time associated with the late Prof. Langley, and helped him very considerably in his experiments. He gives a good deal of general information about these experiments which has not hitherto been published, and emphasizes (though that is hardly necessary) the great importance of Langley's work.

Space does not allow of a detailed discussion of the numerous other essays, many of which are of great interest; but the study of them can be recommended to those who wish to get a good general idea of recent aeronautical progress.

The illustrations are numerous and clear.

J. D. FULLERTON.

THE PROBLEM OF FLIGHT:
A TEXTBOOK OF AERIAL ENGINEERING.

By H. CHATLEY.

This work, which is a somewhat ambitious attempt to provide a textbook of aeronautics for members of the engineering profession, contains a fair amount of useful information. It is doubtful whether it will be found of much practical use, as its general arrangement is somewhat confused, and important aeronautical details, such as the shapes, dimensions, etc., of birds' wings, etc., have either been omitted altogether or only very briefly touched upon. No doubt this will be remedied in future editions, but the want of what may be called more purely aeronautical information is certainly a failing in the present one.

Considering the chapters in detail:—

Chapter I. describes briefly the reasons why the subject has been so much taken up lately, and enumerates the different classes of aerial vessels.

Chapter II. gives a very brief summary of certain general principles connected with flight, and ends with Mr. Chanute's list of points to be attended to when criticizing the design of an aerial vessel.

Chapter III., on "The Helix as a Lifting and Driving Appliance," follows conventional lines, discussing thrust, slip, efficiency, etc. The equations given for calculating the power of propellers, and so on, are useful enough, but some of them, for instance (6), page 18, do not appear to be of much value, while (1) and (4), page 9, are misleading, as the symbol c is apparently used in different senses.

There are some notes on the use of fans for jet propulsion, and various rules for the details of propeller blades are given. Some of these latter seem to be of doubtful utility, such, for instance, as (1), page 23, which would hardly apply in the form given to the curved blades used with aerial propellers.

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The views of the author regarding the elasticity question will probably not meet with the approval of aeronauts, but possibly this matter affects the design of wings and supporting surfaces more than that of propeller blades.

In *Chapter IV.* the aeroplane and the pressure of air against surfaces and bodies moving through it is considered. The formulæ for lift and drift, etc., seem to be those used by Weisbach for windmills, and the results obtained differ considerably from those of other experimenters. The deduction that the best angle of inclination for a supporting surface is between a quarter and half a right angle will certainly not be approved of by aeronauts, who would not think of using such a large angle, except when starting from the ground.

Very little information regarding the resistance of bodies is given. Beaufoy's tables are of no practical use, as the bodies dealt with by him are not suitable for aerial work, while the results obtained by Hutton, Robins, etc., are quite unreliable, owing to the faulty apparatus used by them.

The lift and drift with curved surfaces is hardly touched upon, while the very important question of the movements of the centre of pressure at different angles of inclination is only dealt with in a general way.

In *Chapter V.* aviplanes, or machines of the bird type, are discussed, and notes on wing motion, balancing, etc., are given. As regards the ratio of weight to wing area, the results obtained by Mullenhoff are usually considered to be more accurate than those quoted. (See *Le Vol des Oiseaux*, p. 82.)

Chapter VI. deals with dirigible balloons, and goes into the general theory of the subject (see also Appendix F). The methods of making hydrogen are discussed, Renaud's and Pole's rule for power required are given, and various other details. It is to be hoped that the pig iron recommended for ballast will be used with that discretion advocated by the author, as the indiscriminate discharge of pig iron is hardly likely to render dirigible ballooning a popular form of locomotion.

In *Chapter VI.* the form and fittings of airships are discussed. Various rules, taken from marine practice, are given, but a good deal more information regarding the resistance and friction of the air is required before they can be applied practically. As regards "balancing," it is doubtful whether the views of the author will be approved of by aeronauts. The truth seems to be that good balancing does not depend so much upon the use of special apparatus for controlling the movements of an airship, but upon *the good design of the ship itself.* A well-designed airship is almost (if not quite) automatically stable, and does not require the special balancing devices so often advocated.

The chapter concludes with notes on various instruments required for navigating purposes, a discussion on dynamic stability, etc.

There are a few short appendices, the most important being Appendix H, which contains a brief account of the experiments made by Prof. Langley.

The work is well illustrated, the pictures of the Langley, Maxim, and Zeppelin machines being very clear.

J. D. FULLERTON.

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NOTICES OF MAGAZINES.

Engineering News.

October 31st, 1907.

The Forbes Water Sterilizing Apparatus.—The conditions in the Phillipines—where, it is stated, a very high proportion of the population harbour such parasites as obtain access to the human system through drinking water—has specially drawn attention to the need for a water-sterilizing apparatus. In the words of the article: "If the American or Englishman living in the tropics will drink sterilized water and protect himself from mosquitos, he can live in such countries almost as safely as at home."

The difficulty is to produce an apparatus both sufficiently portable, and at the same time sufficiently cheap in working, which will produce a water agreeable to the palate.

The apparatus under consideration involves the principle of applying heat to the water in a closed receptacle, so that the contained gas will not be driven off, it being so arranged that the stream of water leaving shall be able to impart its heat to that entering, and finally come out at a temperature not much above that at which it entered. The heating arrangement is so devised that the water, which reaches it at a considerable temperature, *boils over*, and then goes on to the part of the plant where it cools and exchanges its heat with the incoming water.

There are several types of apparatus, divisible into two classes—(1), *diaphragm*, in which the supply and discharge sections are separated by a partition; (2), *tubular*, in which the supply water rises through a jacket surrounding a set of tubes in which the discharge water is cooling. The supply is regulated by a float valve.

The U.S. Government has a water wagon on trial constructed on this principle. It is capable of delivering 400 gallons of water per hour, can start delivering water in 11 minutes from cold at a difference of 16° F. between supply and discharge. Weight of the outfit, 3,150 lbs. It consists essentially of a small water-tube boiler; 2″ × 3″ × 2″ Worthington duplex steam pump; double copper cell bone black filter; copper tank for filtered water, and one of 150 gallons capacity for sterilized water, both tin-lined; sterilizer; auxiliary hand pump; seven taps for issue; the whole mounted on a four-wheeled wagon.

It will be remembered that a water-sterilizing apparatus has now been for some time under trial in the British army.

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November 7th, 1907.

STREET RAILWAY TRACK CONSTRUCTION.—Owing to the increase in speed and volume of traffic, the continued adoption of groove-headed rails for tramway or street railway lines has led to the introduction of sections of rail which, when one considers the small stresses brought upon the permanent way, are of enormous size as compared with those on steam railways. In addition to this the difficulties of making good joints and keeping the track in repair are everywhere very great. In fact, the groove-headed rail is almost necessarily less advantageously proportioned than the T-rail, such as is used on steam lines. But in paving it is difficult to ensure the same elasticity in the formation as in a ballasted road, although this is not touched on in the article.

The above considerations have led to the adoption of T-rails on a number of tramways or street railways in the U.S. On some of these, the line is laid on sleepers with a concrete covering to carry asphalte; on others, the rails are laid on concrete much in the customary manner. In either case the filling between the rails seems to consist of vitrified brick bevelled alongside the railhead to admit the wheel flange.

C. E. VICKERS.

MEMORIAL DE INGENIEROS.

June, 1907.

THE DAY OF SAN FERNANDO.—San Fernando was chosen patron of the Corps of Engineers on the 2nd May, 1805, and his feast is always celebrated with special honour.

THE ENGINEER MUSEUM AT ROME AND THE RESTORATION OF THE CASTLE OF SANT' ANGELO.—By Colonel D. Sixto Soto.—The museum was opened on the 13th February, 1906, by the King of Italy. It is installed in the Castle of Sant' Angelo, which has been restored under the direction of Lieut.-Colonel Borgatti, of the Italian Engineers. The exhibits are divided into six groups, dealing respectively with (1) the history of permanent fortification and with the attack and defence of fortresses; (2), works carried out by the Corps of Engineers for the Admiralty; (3), artillery, field fortification, machinery, field bakeries, pigeon lofts; (4), library and collection of drawings relating to fortification; (5), photography and telegraphy; and (6) optical telegraphy, bridging, railways, ballooning. The article contains an interesting account of the castle, and is illustrated by plans of the various floors.

INTERNATIONAL CONFERENCE ON RADIO-TELEGRAPHY.—An account of the Conference held in Berlin in October, 1906, of which full reports appeared in the English press.

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THE MINISTRY OF WAR IN THE MADRID INDUSTRIAL EXHIBITION.—By Capt. D. S. Garcia de Pruneda and Lieut. D. F. González.—A second and final article on this subject appeared in the September number. The exhibition took place this summer on the Retiro at Madrid. Colonel Marvá, the distinguished chief of the Engineer Laboratory in Madrid, was the representative of the War Department, and under his direction a very fine pavilion, of which illustrations are given, was constructed to contain the exhibits of that department. The pavilion was divided into five sections, viz., General Staff, Engineers, Artillery, Medical Department, and Military Administration.

The General Staff exhibited a very interesting collection of maps both ancient and modern, the latter including fourteen sheets of a new map of Morocco, amongst which are to be found plans of Marrakesh, Mequinez, Larache, Tangier, and of various Riff Kabilas.

The Engineer exhibit was very complete, and was furnished by the museum, laboratory, and electro-technical centre.

The articles exhibited in the other sections were also of interest.

CONSTRUCTION OF THE PANAMA CANAL BY MILITARY ENGINEERS.—A translation of an article which appeared in the *Scientific American* of 9th March, 1907.

MILITARY REVIEW.—Great attention has been devoted in Germany in recent years to permanent fortification, and the expenditure under this head has increased from £150,000 in 1893 to £1,150,000 in the present year. The following conclusions are arrived at:—

1. The considerable development given to the German fortifications in recent years does not in any way imply a weakening of the offensive spirit which animates the empire.

2. Fortification is an arm like any other, and obtains all its value in co-operation with the field army, and aids the latter in the execution of offensive operations, tending to the destruction of the enemy's forces.

3. In a well-thought-out plan of campaign, such as the German, the *rôle* to be played by fortresses may be foreseen, or rather preconceived, like the operations themselves, and in which they may form an essential element.

Extracts taken from *A Staff Officer's Scrap-Book* are given from Sir Ian Hamilton's observations on the siege of Port Arthur and the value of its defences.

'M.'

NATURE.

October and November, 1907.

ALUMINIUM CABLES (*p.* 501) have been used in this country and largely in America, but not insulated. The difficulty of making sound joints has prevented a larger use of aluminium for commercial purposes. This

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difficulty has been overcome, and both mechanical and "sweated" joints can be made as desired. The makers claim that the electrical and mechanical properties of the joints are superior to those of the wire itself. The conductivity of aluminium is only 60 per cent. of that of copper, consequently the diameter of the aluminium cable is greater by 28 per cent., but a 50 per cent. saving in weight is claimed over copper conductors of the same capacity. The insulation used is vulcanized bitumen, as being lighter than paper for the same degree of insulation.

"CONCRETE-STEEL BUILDINGS."—By W. N. Twelvetrees (*p.* 576).—The author gives particulars of a number of typical pieces of work in ferro-concrete which have been carried out in the last few years. Engineers who consult this book will find full descriptions of buildings similar to any they may be called upon to design. Copious notes as to the methods of making the concrete, the nature of the reinforcing steel, and of the results of proof tests of the structures, are given. The last chapter contains a brief account of a few noteworthy collapses and of the probable causes of these failures. Much can be learned from inevitable failures.

SCIENCE IN THE EAST (*p.* 593).—A great magnetic survey has been in progress in India for some years. (1). Capt. R. H. Thomas, R.E., has made observations at 808 stations, and hopes in three more seasons to complete the field work. (2). Pendulum observations have also been made by Major G. P. Lenox-Conyngham and his assistants at ten stations, including nine nearly on a meridian passing through Darjeeling. The most northern station was at a height of 11,766 feet. The result of this work will, it is hoped, account for the observed large deflections of the plumb line and the deductions made as to the density of the material underlying the Himalayas. (3). Tidal observations and levelling operations are reported upon by Mr. J. P. Barker. He gives interesting information as to the accuracy of predicted times of high and low water. At the open coast stations the mean error in the predicted times was only nine minutes, and the mean error in the predicted heights was only 3 per cent. of the range. (4). Survey operations of a rapid kind with the Somaliland field force were made by Capts. Beazeley and C. G. Hunter, and successfully carried out under war conditions.

THE PLAGUE (*p.* 648).—Sir Lauder Brunton, in his address to the London School of Tropical Medicine, described the ravages of this disease in Europe in the fourteenth century, under the name of the "Black Death," and quoted from contemporary writers illustrating the terrible condition to which the countries attacked were reduced by the pestilence. In India, at the present moment, the ravages of plague, though not so great as those of the "Black Death" or of the Great Plague in London, are nevertheless dreadful. During the first six months of this year no less than 1,060,000 deaths from plague occurred in India, and out of these 632,000 took place in the Punjaub, which has only a population of 25 millions, that is to say one in every forty inhabi-

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tants in this district has died of plague between January and June. It has long been observed that great mortality in rats is apt to precede pestilence, and it has now been proved that the virus is transmitted by fleas, as 61 per cent. of white rats contracted plague from fleas which had been fed upon infected rats, but that they did not catch plague if they were protected from fleas by wire gauze, adhesive fly-paper, etc. Aerial infection did not take place if the rat was put into a wire cage two feet (that is more than a flea can jump) from the ground. The great difficulties in the way of preventive measures are ignorance, apathy, and superstition. There is great prejudice in some parts of India against taking life of any kind, but this is not universal, because in some parts goats are offered to Kali, the Goddess of Destruction. If the Brahmins could persuade the natives that the sacrifice of a rat as often as possible to Kali would avert pestilence, rats would soon be destroyed, and the plague would be at an end.

THE "MAURETANIA" (*p.* 663) is 800 feet long, nearly the length of the Houses of Parliament. The magnitude of the strains which she must experience in a heavy head sea is brought to mind by the provision which has been made for bending. The boat deck, together with the boathouses upon it, which contain the long suite of public rooms, is cut completely through in three places, so as to allow the ship to give longitudinally. The plates were rolled to a guaranteed thickness, enabling the builders to save 500 tons of dead weight, and the use of silicon steel in the boilers effected a further saving of 500 tons, making a total saving of 1,000 tons, which, reckoned as cargo, represent a gain to the Cunard Company of about £22,000 a year in the earning power of the vessel. Vibration, though moderate, is noticeable; it is at a maximum in the after part, and diminishes thence to the bows. The distribution is, however, erratic, regions of maximum vibration often being close to regions of minimum vibration. The cause of the vibration in turbine ships is not obvious, and at present there is no satisfactory hypothesis to explain it.

ANTARCTIC ANIMALS (*p.* 33) observed in the "National Antarctic Expedition, 1901—1904," are most interesting, and are well reported on by Dr. E. A. Wilson. On a particularly dark night the sea lions, following a boat, could be distinctly seen diving and twisting about beneath in the pitch-black water; each animal was ablaze with light; every stroke of their long powerful flappers was accurately visible in the pitchy darkness by the brilliance of the phosphorescence covering them. The Emperor penguin's egglaying is most curious. The bird chooses the darkest months of the winter in which to incubate its egg; it lays its one egg upon sea ice, with no pretence at nesting, but removes it at once to rest upon its feet, where it is held wedged between the legs, pressed to a patch of bare skin in the lower abdomen, and covered by a loose flap of skin and feathers. The incubation requires seven weeks, and as one bird cannot undertake this task, a dozen others stand patiently round waiting for a chance to assist. Every adult bird, both male and female, has a

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keen desire to "sit" on something. When the sitting bird feels hungry, it hands over its treasure to the nearest neighbour to undertake the duty of incubation.

THE PRESERVATION OF EGGS (*p.* 84).—In an absolutely sterile atmosphere, at a sufficiently low temperature and of a proper degree of humidity, eggs will preserve their "freshness" for very long periods of time, and all successful methods of keeping eggs imply a practical recognition of these principles. The eggs should be put in a cool place with their points down, so that the air can circulate freely round them. Nothing is gained by turning the eggs, or by packing them in salt, sawdust, charcoal, wood ashes, sand, etc. Some of these things taint the eggs, others are apt to set up the action of moulds. Good results are obtained by immersing them in a 10 per cent. solution of water glass, especially if the shells are smeared with fat or vaseline, whereby the slight taste of the alkali, which the eggs are otherwise apt to acquire, may be obviated.

W. E. WARRAND.

REVISTA DE ENGENHERIA MILITAR.

September, 1907.

PROPOSAL FOR THE CREATION OF A SUPREME COUNCIL OF NATIONAL DEFENCE.—By Capt. João d'Oliveira.—A Supreme Council of National Defence was constituted on the 24th December, 1906, under the presidency of the King, and has as its members the president of the council of ministers, the ministers of war and of marine, nine generals and five admirals. It is divided into two sections, one dealing with the army, the other with naval matters. Its object is to take the initiative in making all preparations for war, and to establish—

(*a*). The fundamental principles to which the organization and mobilization of the land, sea, and colonial forces should be subjected.
(*b*). The plans of military and naval operations.
(*c*). The plans for the defensive organization of the capital and the colonies.

The author welcomes the institution of this council, and then proceeds to point out some of the shortcomings of Portugal as regards defence, and the sudden and unexpected manner in which causes of quarrel arise between nations. He thinks it possible that at some future time Spain may endeavour to re-unite Portugal with her dominions, or that some foreign power may cast covetous glances on some of the Portuguese colonies such as Madeira or the Azores. Up to 1890 relations with England were most cordial, but in that year an incident occurred at Chire and Nyassa which showed that no reliance was to be placed on

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any guarantee given by that country, and it was not until the visit of King Edward VII. to Lisbon in 1903 that the friendly feeling between the two countries was restored.—(*To be continued*).

SOME CONSIDERATIONS ON THE FIELD BALLOON PARK BELONGING TO THE MINISTRY OF MARINE (*continued from the August number*).

SOME EXTRACTS FROM THE REPORT OF THE ENGINEER, REGO LIMA.—This portion of the report deals with the geological features of the Bundambungo district, and particularly with the veins of quartz met with there.

THE DEFENCE OF THE COASTS OF THE U.S.A.—A *précis* of articles which appeared in the July and August numbers of the *Rivista di Artiglieria e Genio*. The original project was drawn up in 1880, and was modified by a committee presided over by Mr. Taft, which commenced its sittings in 1906. At that date the following pieces of ordnance were mounted in coast defence works:—105 12-inch guns, 133 9·4-inch guns, 99 8-inch guns, 587 Q.F. guns of smaller calibre, and 376 12-inch mortars.

The Taft Committee made the following recommendations:—

1. Batteries for the defence of ports of primary importance should be armed with guns of a calibre not below 12 inches, with 12-inch howitzers, and with Q.F. anti-torpedo boat guns.
2. 10-inch guns are sufficient to defend the entrances of channels exposed only to cruiser attack.
3. 6-inch Q.F. guns should be employed for the protection of places liable to naval raids, and to command at long range areas from which torpedoes might be fired.
4. 3-inch guns should form the anti-torpedo boat armament at moderate ranges.

The committee considered that a submarine-mining defence was very necessary. In deep channels, or where the currents are too strong to admit of the employment of submarine mines, torpedoes should be used.

Great stress was laid on the electric-light defence, and it was considered that as a rule a central generating station for the current should be employed, but in order to minimize the effects of a lucky shot, subsidiary generating stations equipped with internal combustion engines should be established in each group of batteries. Special lights should be told off to the minefields. 3-ft. and 5-ft. projectors are recommended, as the former 2-ft. and 2-ft. 6-in. projectors are considered insufficient.

THE WAR BUDGET OF GERMANY FOR 1907.—The following are the more important items, referring to the engineer arm, which have been included in the budget:—

1. Creation of an additional battalion of pioneers, bringing the total number up to 27.

2. Engineer Committee; formation of a fourth section to deal with fortress warfare.

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3. Establishment of a school at Strasburg for training clerks of works for duty with the Fortress Construction Corps.

4. Sale of lands and materials from certain disclassed fortifications at Posen, Strasburg, Diedenhofen, Graudenz, and Ulm.

5. Fortresses. (*a*). The following additions are made to the fortress staffs at Metz and Strasburg:—One field officer of the communications troops to be in charge of all the communications of the fortress; one mechanist to look after the motor cars, gas works, and wireless telegraphy apparatus; two warrant officers to take charge of the balloon, signalling and railway material.

(*b*). £15,000 are allotted for strengthening the fortifications of Germersheim; £150,000 for works at Maiz and Castel; £11,250 for Ulm; £300,00 for Cologne.

6. The sum allotted for the training of the pioneers is increased by £3,120, and that for the training of the communication troops by £8,800.

7. Formation of an additional telegraph battalion, and of a wireless detachment consisting of 1 captain, 6 lieutenants, 1 warrant officer, 13 sergeants, 92 men, 12 riding and 40 draught horses.

8. Formation of a mechanical transport detachment (1 captain, 4 lieutenants, 20 sergeants, and 150 men) attached to the experimental section of the communication troops.

9. Appointment of a major-general as inspector of telegraphs troops.

10. Large increase in the amount allotted for the purchase of telegraph material, and for aeronautical services.

'M.'

REVUE DU GÉNIE MILITAIRE.

October, 1907.

THE INFLUENCE OF THE FIGHTING ROUND PORT ARTHUR ON THE CONSTRUCTION OF FORTS.—This article is a digest of various articles which have been published by Lieut.-Colonels von Schwarz and Barmin, in the *Eenzhenernee Zhoornal*. It is accompanied by an excellent map of the fortifications round Port Arthur, reproduced from the same magazine. The first portion of the article is devoted to a description of the works, their armament, and their field of fire. It points out that the general line of defence was too near the town and harbour, and very few of the works had been finished before the outbreak of hostilities. After the war had commenced, the following works were put in hand:—The completion of Fort No. 1, Kikwan North, and Ehrlong, and the construction of temporary works and trenches in the intervals between the forts and of temporary batteries. After the loss of Nanshan, the Russians commenced the construction of head cover, splinterproofs, and obstacles; among the latter was a bare electric wire carrying an alternating current of 3,000 volts, and extending from Kikwan North to Itsushan. Profiting by the respite given by the Japanese during May, the Russians constructed some advanced works.

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The Kuropatkin and Temple Redoubts were commenced first, although the fortification of Takushan was of more importance. Differences of opinion among the senior officers led to the postponement of the more urgent work. During the middle of May the hills Plate (Akasaka), "de la Division" and Panlongshan were fortified. It was not till the middle of June that work was commenced on Siaokushan and Takushan. The soil was so rocky at these important points that progress was very slow, and the works had hardly been begun before the Japanese attacked them. The mistakes committed by the Russians clearly show that for each fortress a proper defence scheme should be drawn up in peace time, so that on the outbreak of war the various works may be taken in hand in the order of their importance. At Port Arthur there was no such scheme, and, as a consequence, the following points were overlooked. The communications were not screened from the enemy's view; the telephone lines were left exposed to the enemy's artillery; and the central enceinte was so exposed, owing to the omission of traverses and shelters, that it was useless. After describing in some detail the state of the various works on the 30th July, the author draws attention to the following points:—

1. On the right flank the permanent forts were too close in. It would have been better to advance the right flank to Takushan and Siaokushan, thus obtaining a shorter and stronger line.

2. Takushan and Siaokushan were badly fortified, and consequently very weak.

3. The line of forts was too close to the town, especially on the west front, where it was only one kilomètre away. It was thus possible for the enemy to bombard the town and harbour with guns of all calibres.

4. Out of six forts only one was finished.

5. There was much dead ground between the forts.

6. Some of the forts could neither see nor support their neighbours.

7. The intervals between the works were closed by old Chinese earthworks, or slight trenches, which had a very limited field of fire and could not resist an assault.

8. The forts had no arrangements for flanking fire, and the caponiers were badly designed.

9. On account of their unfinished condition there were dead angles in all the forts except Songshushan.

10. Krupp guns were mounted in all the works.

11. There were no shelters for the guns detailed to repulse assaults.

12. In some of the forts there were no guns to flank the ditches.

13. The roofs of the shelters had only 90 centimètres thickness of concrete.

14. The temporary batteries were built on the tops of the hills, and were visible from afar.

15. There was a deficiency of howitzers and an excess of old pattern guns.

16. Practically all the works and batteries were visible to the enemy.

17. The communications were not screened.

18. There was no trench tramway material available.

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19. There were no observatories.

20. There were no protected look-out stations in the forts.

21. There was no special telephone circuit devoted to the artillery, and the general telephone service was bad.

22. All the telephones were operated by air lines only.

23. There were only 15 searchlights, of which 12 were fixed.

24. There was a wireless telegraphy installation, but it would not work.

25. There were no balloons.

26. The reserve of material was small, and had been drawn on already by the field armies.

The article will be continued.

J. E. E. CRASTER.

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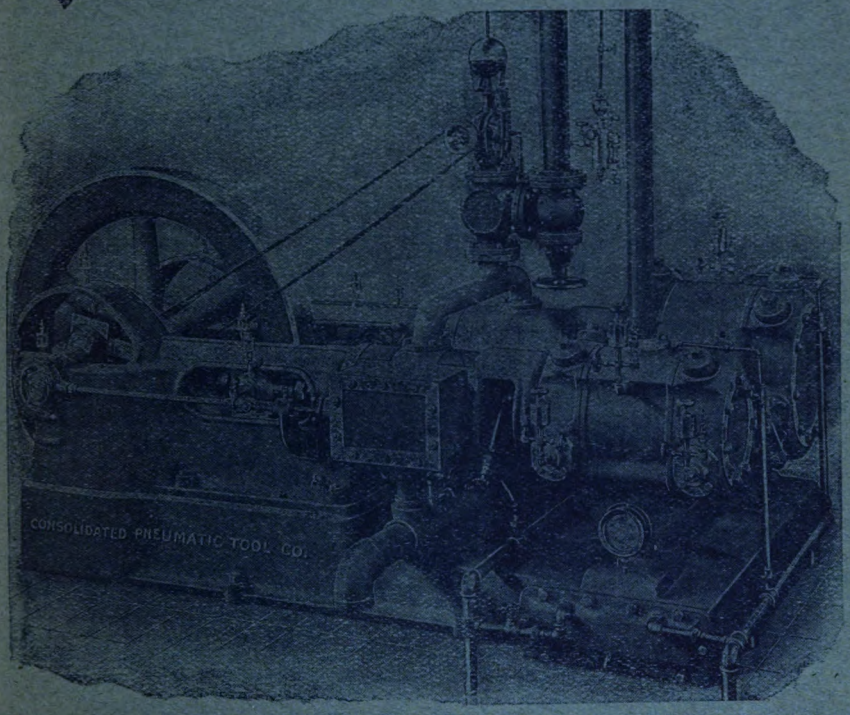

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Recent Successes Include:—

STAFF COLLEGE, AUGUST, 1906.

The following Officers, whose names are arranged in regimental order, were successful from us at the recent Competitive Examination for admission to the Staff College.

Capt. C. Evans, R.F.A.
,, G. C. Merrick, D.S.O., R.G.A.
,, W. H. Moore, D.S.O., R.G.A.
,, J. P. Mackesy, R.E.
,, B. W. B. Bowdler, R.E.
,, F. D. Farquhar, D.S.O., Coldstream Guards.
*Capt. R. G. Parker, Rl. Lancaster Regt.
Capt. G. N. T. Smyth-Osbourne, Devonshire Regt.
Capt. V. H. M. de la Fontaine, East Surrey Regt.
Capt. and Bt. Major F. R. Hicks, Hampshire Regt.
Capt. H. S. Williams, Dorsetshire Regt.
,, B. D. L. G. Anley, D.S.O., Essex Regt.
Capt. R. S. Hamilton-Grace, Durham Light Infantry.
*Capt. H. F. Baillie, Seaforth Highlanders.
,, P. S. Allen, Gordon Highlanders.
,, J. K. Cochrane, Leinster Regt.
,, R. L. Ricketts, Indian Army.
,, W. K. Bourne, Indian Army.
,, F. W. Lumsden, R.M.A.

The following Officers received nominations:—

Capt. H. C. Bickford, 6th Dragoon Guards.
Capt. C. J. C. Grant, Coldstream Guards.
Capt. W. D. Wright, V.C., Royal West Surrey Regt.
Capt. C. H. Harington, D.S.O., Liverpool Regt.
Capt. H. Wake, D.S.O., King's Royal Rifle Corps.
Capt. and Bt. Major N. J. G. Cameron, Cameron Highlanders.
Capt. G. P. Grant, D.S.O., Indian Army.

SANDHURST, JUNE, 1906.

FIRST	A. G. Armstrong 5,541	129th	R. P. T. Ffrench..... 3,827
48th	H. G. Gauntlet 4,515	181st	C. W. Molony..... 3,445
67th	D. Macdonald..... 4,299	186th	P. J. I. Synnott 3,386
89th	W. G. Bagot-Chester..... 4,115	190th	R. M. Aylmer 3,339
90th	A. G. Ottley 4,109	197th	O. Gough..... 3,262
93rd	A. P. Williams-Freeman 4,094	201st	P. W. J. A. Stomm 3,151
115th	D. M. Black 3,940	213th	B. W. Molony 2,881
125th	W. J. King-King 3,846		

WOOLWICH, JUNE, 1906.

31st ... ... J. S. Barkworth 6,483

DECEMBER, 1905.

SECOND	H. G. MacGeorge 7,196	16th	R. Crofton 6,330
FOURTH	G. Walton 7,046	45th	D. Stephenson 5,899
FIFTH	H. A. Cox 6,967	54th	J. Kennedy 5,711

This was the First Examination under the new regulations, and our pupils secured THREE out of the first FIVE places.

MILITIA COMPETITIVE, MARCH, 1906.

A. E. Hardy	 2,304	W. F. Anderson	 1,947
N. H. Hutcheson	 2,105	D. C. Robinson	 1,879
F. D. Frost*	 1,949	F. A. Bowring	 1,876

*Read partly at the Army College, Aldershot.

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U C L. DUPLICATE

THE ROYAL ENGINEERS JOURNAL.

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CONTENTS.

	PAGE.
1. **Government Offices, Bangalore.** By Lt.-Col. O. M. R. THACKWELL, R.E. (*With Photo and Plate*)	61
2. **The Tactical Use of R.E. Field Units.** By Major C. S. WILSON, R.E. ...	62
3. **Military v. Naval Home Defence.** By Major W. A. HARRISON, R.E.	65
4. **The Foundation of the Royal Engineer Establishment at Chatham.** By Lt.-Col. B. R. WARD, R.E.	72
5. **Memoir:**—Major-General William Spottiswoode Trevor, V.C. By Col. J. P. STEEL, late R.E.	79
6. **Transcripts:**—The Use of Entrenchments and Field Fortification in the Attack. (From the *Journal of the United Service Institution of India*) ...	86
Explosion of Gelignite in Pembrokeshire. By Major E. G. GODFREY-FAUSSETT, R.E.	115
7. **Notices of Magazines**	117

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CONTENTS.

PAGE.

1. GOVERNMENT OFFICES, BANGALORE. By Lt.-Col. O. M. R. Thackwell, R.E. (*With Photo and Plate*) 61

2. THE TACTICAL USE OF R.E. FIELD UNITS. By Major C. S. Wilson, R.E. ... 62

3. MILITARY *v.* NAVAL HOME DEFENCE. By Major W. A. Harrison, R.E. ... 65

4. THE FOUNDATION OF THE ROYAL ENGINEER ESTABLISHMENT AT CHATHAM. By Lt.-Col. B. R. Ward, R.E. 72

5. MEMOIR :—

Major-General William Spottiswoode Trevor, V.C. By Col. J. P. Steel, late R.E. 79

6. TRANSCRIPTS :—

The Use of Entrenchments and Field Fortification in the Attack. (From the *Journal of the United Service Institution of India*) 86

Explosion of Gelignite in Pembrokeshire. By Major E. G. Godfrey-Faussett, R.E. 115

7. NOTICES OF MAGAZINES :—

Engineering Record. By Capt. C. E. Vickers, R.E. 117

Memorial de Ingenieros. By 'M.' 117

Nature. By Major-Gen. W. E. Warrand, D.L., late R.E. 120

Rivista di Artiglieria e Genio. By Col. Sir Edwd. T. Thackeray, V.C., K.C.B., late R.E. 122

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GOVERNMENT OFFICES, BANGALORE.

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GOVERNMENT OFFICES, BANGALORE.

By LIEUT.-COL. O. M. R. THACKWELL, R.E.

THIS building was designed by Mr. J. E. O'Shaughnessy, M.I.C.E., a retired member of the Public Works Department resident in Bangalore, and the building was carried out under the supervision of successive C.R.Es. of the Bangalore Military District, some modifications in the design being made in course of construction.

It provides accommodation for the Courts and Offices of the District Magistrate, the 2nd Magistrate and the Bench Magistrates, for the Resident's Treasury, and for an Excise Office: a Police lock-up for prisoners under trial is provided, and various waiting rooms for the Pleaders and public attending the Courts.

The building is double-storeyed, and the style of the architecture is Florentine. The roof of the 2 end portions is a sloping roof of local Mangalore tiles; these are joined by a flat roof of the kind known locally as Madras terrace: the whole of the roof is surrounded with a low panelled parapet wall.

The lower storey is built of granite of which there is an abundant local supply, the upper storey was designed of brick for the sake of lightness; both storeys are lime plastered on the outside. For similar reasons the floors of the lower story are of stone, while those of the upper storey are of tiles on concrete over corrugated iron jack arches supported by steel girders.

Both roofing and flooring tiles were obtained locally, being manufactured in large quantities in the South of India: good bricks are however difficult to obtain, and those used in the work had to be specially made by the contractor.

The building was commenced in 1902 and took nearly 2 years to complete. There was at first great difficulty in obtaining a contractor to undertake the work at the rates laid down: once however that difficulty was overcome, the work proceeded without hindrance.

The actual cost of the building was Rs.1,78,000, or 8 rupees 14 annas per square foot of plinth area; the cost per cubic foot (plinth area x average height of roof above plinth) was 3 annas 2 pies.

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THE TACTICAL USE OF R.E. FIELD UNITS.

By Major C. S. Wilson, R.E.

It seems unfortunate that in the new edition of *R.E. Training* no mention has been made of the tactical handling of R.E. field units. In *Combined Training*, also, there is an absence of guiding in this subject, almost the only mention being of the use of R.E. in advance guards. Whilst recently in command of a field company I found this omission a great handicap in obtaining the most useful training results from field days and manœuvres, as it was not only necessary to devise the best method of utilizing the unit, but it was also necessary to get the General to adopt them and embody them in his orders. However ready the General may be to listen to views submitted to him, at present a field company commander's proposals embody his own personal opinions only, instead of properly laid down general principles. If such existed the General would at once realise that the suggestions submitted to him are accepted principles and not original ideas of your own. Of course, in peace time, the work must be to a very large extent imaginary, but it is most important to accustom the R.E. themselves to be in their proper places in any scheme of attack and defence, and other arms should be taught to realise that this will always be the case.

In a recent article in the *R.E. Journal* Capt. E. E. B. Wilson, D.S.O., dealt with this question on the march, and the same reasoning, viz. that it is the duty of the R.E. to clear the way for the infantry, applies equally in the attack. In order to do this the R.E. must be well to the front and not kept in reserve. Judging from the foreign journals, this is being realized on the continent, and divers proposals are being put forward either of attaching sections of engineers to the infantry or of training sections of infantry as engineers. Both these suggestions seem undesirable as they would probably result in the engineers being used as infantry when they might be better employed elsewhere, but they show that the importance of having the engineers always up with the infantry is becoming recognized.

The first duty of engineers in the attack is to clear the way for the infantry through any natural or artificial obstacles which may hinder the advance. This entails very careful reconnaissance, both before and during the attack, as the exact nature of the obstacles close up to the position can rarely be ascertained beforehand.

The second duty is to seize every opportunity of improving cover

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and entrenching against a counter attack, and of preparing gun positions where required as each successive feature of the ground is made good in the advance.

In peace time this work although imaginary needs very careful organization and training, especially as regards the following points:—

Reconnaissance.—Men must be trained as scouts in the same way as is done in the infantry, and they must be taught to go forward with the infantry scouts and send back accurate reports of the obstacles to be cleared and the tools required; this will require a great deal of practice in getting reports back quickly and in time to be of service.

Supply of Tools.—This is also a question which requires very careful consideration and forethought, as we cannot hope to get the tool carts much nearer than 2,000 to 2,500 yds., or the pack animals within 1,500 yds., excepting on particularly favourable ground. Beyond this point the sappers must carry their own tools, and as they can only take about one tool a man, the need of early and accurate information as to the work to be done is evident. There will be no possibility of changing at the last moment if the wrong tools are brought, and the delay in getting the right ones up from the tool cart, over a mile of fire-swept ground, would be disastrous. The use of grenades and portable mortars of the Japanese pattern, when close to the position, must also be thought out and arranged for.

Another important point is the training of the mounted N.C.O.'s and men in getting their pack horses and tool carts under cover as close up as possible to their sections, and also in keeping in communication with them. To carry this out, the use of any cover afforded by the natural features of the ground, as well as the best way of crossing exposed places, will have to be very thoroughly taught.

Training is also required for officers and N.C.O.'s not only in rapidly recognising the salient features for defence as the attack progresses, but also in strengthening them as quickly as possible, and further, as the advance goes on, information of what is being done must be passed to the rear, so that the second line may be ready to take over and complete the work when it reaches it.

From the above it will be seen that there is a great amount of useful training to be got out of a drill attack. But to get this the R.E. must be up in their places and allotted to the sections of attack. Within this section they should have freedom of movement, and although a section might be ordered to move with a battalion it should not be tied to any particular formation or position, these details being left entirely to the discretion of the R.E. officer in charge.

The following arrangements, carried out in an attack last summer, will explain this idea. The attacking force consisted of 1 brigade R.F.A., 1 field company R.E., and 1 infantry brigade. The front was divided into 2 sections, one battalion allotted to each. The

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left battalion, employed in the main attack, was supported by another battalion, and the remaining battalion was in reserve. One section R.E. was allotted to the 1st line of each battalion, the remainder of the company following in the second line. The country was open heath crossed by wire fences, banks and stone walls. Each of the sections in the front line sent forward 2 or 3 men as scouts, and a few men with wire cutters and crowbars to clear the fences and to loophole walls, etc. The remainder of the section followed the supports, improving cover made in the advance, and preparing any special points for defence. The remainder of the company completed the work as the second line advanced. During the whole advance, communication with the main body was kept up by message and signal from the scouts and sections. This was very imperfectly done, partly owing to the shortness of a peace attack and partly through evident want of practice. It is most important however that the successive lines should know what is going on in front, so that the work begun may be carried on at once without wasting time by looking out for what has been done, and this depends on good signalling. The rapidity of the peace attack is really an advantage, as it emphasises the necessity of information, as to work and tools required, being passed rapidly, if any use is to be made of it.

A point to be observed is, that the R.E. must not wait to finish the work they start, but must move on with the troops, leaving its completion to the R.E. with the line behind.

It will be seen that a field company just about fills the requirements of a brigade, and I am strongly of opinion that each brigade should have a field company available, even though they should still be Divisional Troops and not part of the brigade.

The increasing use of prepared obstacles in the defence, and of the spade in the attack, makes the engineer arm of particular importance, and it should therefore be accustomed to work with the other arms as much as possible. One point of view, sometimes held, needs contradicting, and that is that the R.E. are too valuable to be used. Their work, which is their real value, is lost if this opinion is insisted upon.

The above is really only a short outline of what may be done, but I hope that others may be induced to give their views more fully, so that in time the principles of the tactical use of R.E. may be recognised and included in the text books.

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MILITARY v. NAVAL HOME DEFENCE.

By MAJOR W. A. HARRISON, R.E.

IN the November number of the *R.E. Journal,* Major Fuller not only disagrees with the system of Home defence advocated by Colonel Hickson, but goes further and advocates in its place the Naval defence of Great Britain as part of the Empire only, instead of the Military defence of Great Britain as the heart of the Empire, and, as such, its most vital organ. If, as his article would lead one to believe, he is an advocate of the "Blue Water School" principles, many will surely hold his views as far more unsound than those which he opposes.

These "Blue Water School" principles may be summed up as :—

(1). The whole Home defence entrusted to the Fleet.
(2). A military force large enough to act as a striking force, but totally inadequate to protect England against invasion.
(3). The impossibility of such an invasion on account of our Fleet always being in sufficient force, where needed, to guarantee the safety of our shores.

Major Fuller may disclaim any connection with No. 3 of the above tenets, but the two first principles are evidently unsound unless absolute reliance is placed in the third.

An exponent of this school—Mr. Harold Cox—writing to the *Broad Arrow* on the 2nd of November, 1907, says : "The question of whether foreign troops can be prevented from landing on our shores is entirely a Naval one . . . and the only authority on this is the Admiralty. Their opinion is that the Navy can prevent the landing of any force exceeding from 5,000 to 10,000 men . . . therefore we may dismiss altogether from our minds the fear of invasion."

Even if Major Fuller does not entirely agree with the above extreme opinion, it will show him the great danger there is of the views such as he holds being dangerously misapplied by civilians.

Owing to the susceptibilities of other nations, it is always undesirable to specify what nation might find herself almost compelled, by self-interest, to take advantage of a favourable opportunity of striking a blow direct at the heart of the Empire, so as either to increase her over-sea dominions, or to supplement her foreign markets. It is equally undesirable to point out what combination of circumstances might lead to such an opportunity occurring.

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It is owing to this that the advocate of the "Blue Water School" has such an advantage with the "man in the street," he is able to put all his arguments forward, whereas those of his opponent are mostly "Confidential."

Before going further it may be interesting to consider not only the present distribution of the Fleet consequent on the acceptance of the "Blue Water" theories, but also some of the disadvantages which will result from a Naval defence of Great Britain.

The present distribution of our Fleet is as follows :—

	Battleships.	Cruisers.	T.B.Ds.	Attd. Ships.
The Channel Squadron consists of	14	9	24	7
The Atlantic Fleet...	6	7	—	1
The Mediterranean Fleet... ...	6	8	11	3
Home Fleet (divided into Nore, Portsmouth and Devonport Divisions)	23*	37†	108‡	—
North American and West Indies Fleet	—	3	—	3
China Squadron	—	6	7	16
East India	—	4	—	3
Australia	—	9	—	—
Cape of Good Hope	—	3	—	—
West Coast of North America ...	—	1	—	—

Comparing this with the distribution in 1897 as given by Whitaker, we find that at that time the ships in Home waters, including the Mediterranean, were :—18 Battleships, 15 Cruisers, 10 Torpedo-boat destroyers, and 10 "attached" ships; whilst those for the protection of the rest of the Empire were :—2 Battleships, 52 Cruisers, 9 Torpedo-boat destroyers, and 48 "attached" ships of various sizes. In addition to those commissioned in Home waters, there were about 14 effective Battleships, 50 Cruisers (principally IInd and IIIrd Class) and some 80 Torpedo-boat destroyers out of commission, but apparently the number given above were considered sufficient to meet any emergency and protect our commerce if called upon suddenly to do so. In 1897 although Great Britain was practically as unprepared for a military defence of her shores as she is now, theoretically a military as against a naval defence was provided for, and for this reason the ships of the Home Squadrons might be considered as commerce protectors and destroyers of an enemy's Fleet only. Since 1897 the trade of the United Kingdom has increased by 300 millions, whilst that of the rest of the Empire has increased by

* 11 "Special Service."
† 10 "Special Service."
‡ 28 Full Crews, 80 Nucleus Crews.

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200 millions, but whereas the Squadrons in Home waters have been practically trebled, the number of ships available for the protection of our trade elsewhere has been more than halved. Some may urge that this increase at Home is due to the increase in the French and German Fleets, but on the other hand the Russian Fleet has practically disappeared, and the Fleets of Japan and America have more than equally increased in the Far East and America. If the increase of trade in these parts of the world, not only needed no extra protection, but even allowed of a reduction of protecting ships, it is fair to assume that the enormous increase of ships in Home waters is due to our Naval protection against invasion. Thus the first great disadvantage of Naval defence is that, even in peace time, it ties up in Home waters an undue proportion of our fleet, to the detriment of our prestige and trade in the more distant parts of our Empire.

What applies in peace applies doubly in war. It is all very well for "Blue Water" enthusiasts to claim that, whilst our main fleet is seeking out and destroying the hostile fleet, our residue would more than suffice to secure the Channel, but when it comes to the time itself it will be found that every ship is required to place victory beyond the possibility of doubt. During the Russo-Japanese War, whilst the main Japanese Fleet was awaiting a sortie of the damaged and dispirited Russian Fleet from Port Arthur, the Vladivostock squadron came right down to the mouth of Tokio Bay, and hung about there for 4 or 5 days in the hope of capturing certain neutral vessels which were known to have contraband on board. Admiral Kamimura's Squadron, although theoretically free to deal with these ships, left them severely alone, as Admiral Togo needed his fleet to put the issue beyond doubt in case the Russian Fleet made a sortie. So with us; however many "Power" standard our Fleet may be theoretically, it will be found, when war is actually declared, that our Admirals will not wish to spare any of their ships to play "Coast-guard."

A second disadvantage is that Naval warfare is very much like the letter *x*—an unknown quantity. Our fleet has had no real experience of naval warfare for nearly 100 years, and although we believe and trust that it will prove as capable at modern warfare as it did in the Naval warfare of 100 years ago, still it is surely unwise to entirely trust our National existence to a pious belief.

"Blue Water" enthusiasts may talk of our fleet "seeking out and destroying" the enemy's fleet, but in case of war actually occurring, popular "funk" would probably develop to such an extent that it would result in a very strong portion of our fleet being kept on patrol duty in the Channel, so as to guard against any possibility of hostile transports slipping through and landing a large invading force.

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The increase of commissioned ships due to Naval defence has been shown above as being approximately 31 Battleships, 46 Cruisers, and 133 Torpedo-boat destroyers, the initial cost of these ships may be put approximately at £70,000,000 at least, and the annual deterioration at £3,500,000. When it is realised that in 1907 the pay for the whole of the Regular Territorial Regiments of the Line was put at £2,320,000, it will be obvious that the saving in deterioration alone would be sufficient to bring our defending force up to the required strength. In addition to the above sum however the coal bills, the percentage on the original cost of construction, the pay of the crews (a considerable army in themselves), the annual cost of repairs, and finally the dead loss which is incurred by the accidents which so frequently occur, would provide a sum far in excess of what the Military defence of Great Britain would cost. The Naval Estimate for 1896—1897 for effective services only was £19,659,000 net; last year it had increased to £28,908,708 and this increase of £9,300,000 may, I think, be fairly put down to the theory of Naval Home defence. The argument that, with so large a number of ships available, the protection of our commerce is better assured, is an argument which has only come into existence since Naval defence supplanted Military defence in England, and is also one which is hardly justified, seeing that our increased commerce is met by a reduction of protection in all parts of the world excepting in the vicinity of Great Britain. And finally, to all the above disadvantages, is added the overwhelming danger of a sudden invasion of Great Britain. Of course the advocate of naval defence objects even to the suggestion that such an invasion is possible, but as the leading soldier of our day—Lord Roberts—has, in the House of Lords, openly stated his belief that such an invasion is perfectly possible under present conditions, not only on a small but also on a large scale, military men may feel pretty sure that sound reasons exist for such a belief.

It is not proposed to consider such an eventuality separately, as it is evident that, if a suitable scheme of Military Home defence is carried out to protect England against invasion during wartime, the number of men required will more than suffice to protect her against a sudden unforeseen invasion, even though it be on a very large scale.

There is one further great advantage in Military Home defence, and that is that it would free the Navy at once for the proper protection of our far distant interests and commerce. For this, if for no other reason, the question of Military Home defence is worth considering.

The main disadvantage of Colonel Hickson's scheme of defence is that the attempt to be strong everywhere generally ends in the result of being strong nowhere. If a single line of forts, as suggested by Colonel Hickson, was by any chance penetrated at any one point, the whole system would at once become useless, and the "defending

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force," having been calculated on the assumption that it would be required to work only in conjunction with the forts, would probably prove to be too weak to meet, unsupported, a large invading force.

Besides the above, such a chain of forts as proposed would have the following further disadvantages :—

(1). The cost of building and maintaining them would be very great, if not absolutely prohibitive.
(2). The forts would either have to be constantly brought up to date, or would probably be obsolete when the threatened invasion took place.
(3). They would tie up a large number of men, as garrisons, when their presence would be needed in the field army.
(4). Permanent works, unless they act as auxiliaries to the field army, are never justified except in the defence of Dockyards, Arsenals or Naval Bases.

Colonel Hickson lays stress on the fact that his suggestions apply to the South coast alone, as this is, in his opinion, the danger point of England. In these days the East coast is surely looked upon as far the more dangerous, at least from the point of view of invasion.

For all these reasons many will be found to disagree with Colonel Hickson's proposals.

But there is an alternative and less costly way of preparing our Home Defence.

Soldiers are constantly having it pointed out to them, that it is not only instructive, but also absolutely necessary for them to make a minute and thorough study of all possible theatres of war where British troops may be engaged. The Franco-German and the Russo-Japanese wars are held up as brilliant examples of the efficacy of such study. As a matter of fact, in most of our wars, such a study is difficult, if not almost impossible. The enormous extent of the British Empire, the savage and unexplored lands in which we fight, added to the impossibility of gauging the moves of semi-savage enemies, all hamper the British general from working out a preliminary plan of campaign. The case, where such a preliminary plan could be worked out with comparative thoroughness, is the invasion of England.

Of course the possible number of invaders would first have to be arrived at, and this should be fixed by the most disadvantageous and yet possible combination of circumstances which might occur. For instance it might be roughly fixed as follows :—

Our Australian Colonies—coerced as they are by trade unions—find it necessary at times to entirely or partially restrict the immigration of alien workmen. A few years ago such restrictions were carried out only on a small scale, and affected the subjects of

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powers weaker than the Colonies themselves. Every year however the subject becomes a more burning one. The trades unions with their increasing influence, make, year by year, increased demands, and the immigrants refused admission are now subjects of Powers, whose increasing naval strength is likely to become a serious menace to British Far-Eastern superiority in the near future. In case therefore of these immigration laws being resented and leading ultimately to an appeal to arms, a very strong contingent of the British Fleet would be needed in Far-Eastern waters. If in addition to this (or even perhaps on account of this) a serious recrudescence of the recent Turkish trouble with regard to Egypt took place, it would lead to the presence of our Mediterranean Fleet in the vicinity of Turkey, and an enemy might be found strong enough to hold the Channel against the residue of our fleet for say 9 days, *i.e.* 3 days of preparation and 6 days actual transportation of troops. Nine days are taken as available, as it is assumed that, on receipt of the first news, the Mediterranean Fleet would at once hurry home, and the North American Fleet would also hurry over to England and each of these fleets would take about 9 days to reach the Channel.

Working on this basis, the force required to repel such an invasion might be arrived at by considering the problem under every possible condition, in each case the most unfavourable combination of circumstances being assumed against the defending force. Each possible landing place might be taken in turn, and the objective of each, the roads of advance, probable moves with the corresponding countermoves, difficulties of transport, communications, etc., being considered in turn.

The best positions of offence and defence on the various lines of advance, in connection with each scheme, might be thoroughly studied and surveyed, their weak points noted, and the number of men required to ensure success carefully considered. By this means some idea of our requirements in case of invasion would be formed, and, by testing and re-testing the problem, a really practical scheme of defence would ultimately be arrived at.

When the number necessary for Home defence under every condition had been finally arrived at, the logical conclusion is that the regular Home army should be raised to, and maintained at, that number. If the opinion of the late Colonel Henderson is of any value, we may assume that the Territorial Army will be unfitted, until some months after the outbreak of war, to cope with an army composed of Regulars. It can, therefore, only be considered as supplementary to the force required for Home defence, and our defensive force should be fixed irrespective of it. If such an army be provided, it will include the "striking force" which is apparently considered of such primary importance. It is evident that the circumstances which make for invasion are so dissimilar from those which

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require the provision of a "striking force," that it is unnecessary to provide for both the "striking force" and the "defending force" at one and the same time.

Some may hold that the above scheme is carried out piecemeal in the General Ideas of Staff Rides, etc., but, when any details of it do occur, the defending General is always given ample troops either to hold his own until help arrives, or else to tackle the enemy "on his own" with a more than equal chance of success, and this makes the problem an entirely different and much easier one to solve. If an invader really came, the General would find it a very different job to repel him with about $\frac{1}{10}$th the required number of men.

It is just possible that some such scheme, as outlined above, already exists in the safes of the Intelligence Department, but, if so, it has never been carried to the logical conclusion mentioned above.

Finally, even if an invasion never takes place, England would surely benefit by having ample troops always ready to press home any advantage gained by the fleet, and also in case of a war such as we have recently had in South Africa, our having them would obviate the necessity of having to pay patriotic yeomen 5s. a day to render semi-amateur aid. In addition to this the fleet would be free to patrol the Empire and to show the flag as it used to do, and the knowledge that it was again an ever-ready weapon of offence, would be sure to add weight to our wishes or opinions in the Councils of other Nations.

For all these reasons, plausible though the "Blue Water" theories may be, many will hold that Military Home defence is the only really satisfactory solution of the defence of the heart of the Empire. Unfortunately this mode of defence does not commend itself yet awhile either to the bulk of our politicians or to the "man in the street." Some of the former possibly study their popularity and the latter thinks of his comfort. Military Home defence would ruin the one and destroy the other, for, were it adopted, conscription, in some form or other, would only be a question of time, and this terrible bugbear of many a working-man and "patriot" of to-day, is the insuperable obstacle which at present stands between England and Military Home defence.

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THE FOUNDATION OF THE ROYAL ENGINEER ESTABLISHMENT AT CHATHAM.

By LIEUT.-COL. B. R. WARD, R.E.

AS the S.M.E. may well be termed the "Alma Mater" of the Corps, the history of its early days, as also that of Sir Charles Pasley, its founder, should prove of interest to all R.E. Officers.

Capt. H. W. Tyler has written an interesting sketch of Pasley's life in the *R.E. Professional Papers*, and in addition Colonel Vetch's article in the *Dictionary of National Biography* and Major-General Porter's *History of the Corps* give good accounts of his services.

I propose in the following pages, however, to show how the necessity for a school of R.E. instruction first came to be realised, and further what circumstances led to the selection of Pasley as its organiser and first Director. A short summary of his services before the foundation of the School in 1812, taken from the above memoirs, may not be out of place, showing as it does the experiences on which both the original conception and organization of the School were based.

Born at Eskdalemuir, Dumfriesshire, on the 8th September, 1780, Pasley joined the R.M.A. at Woolwich in August, 1796. On the 1st December, 1797, he was gazetted 2nd Lieutenant in the Royal Artillery, and on the 1st April, 1798, he was transferred to the Royal Engineers. On the 28th August, 1799, he was gazetted 1st Lieutenant, on the 1st March, 1805, 2nd Captain, on the 18th November, 1807, 1st Captain. From 1799 to 1807, he was on service in the Mediterranean, at Minorca, Malta, Naples, and Sicily. In 1804, while still a subaltern, he was sent from Malta on a confidential mission to Lord Nelson, during the period of the long and tedious blockade of Toulon. On the 4th July, 1806, he was present at the battle of Maida in Sicily, and in 1807, he was present at the bombardment of Copenhagen and the seizure of the Spanish Fleet.

In the spring of 1808, while on duty in England, he wrote the first two chapters of his famous *Essay on the Military Policy and Institutions of the British Empire.* In the same year he served in Spain under Major-General Leith, who was acting as Military and Diplomatic Agent to the various revolted Spanish Juntas, and on the 18th November, on account of his knowledge of Spanish, he was appointed extra aide-de-camp to Sir David Baird. A

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week later, on the 25th November, he joined Sir John Moore's staff, and accompanied him throughout the famous retreat which had commenced the day before, and which culminated at the battle of Corunna on the 16th January, 1809. Later on in the year he accompanied Lord Chatham on the ill-fated Walcheren expedition.

On 14th August, while leading an assaulting party at the siege of Flushing, he received a bayonet wound in the thigh, and almost immediately afterwards he was struck by a bullet which caused an injury to the spine. In consequence of his wounds he was invalided for a year. For a long time he was not expected to survive the shock but an excellent constitution enabled him to pull through. So severe were these wounds that they completely incapacitated him from any further active service, "and it tells much for the character of the man," says General Porter in his history, "that he did not permit the misfortune to damp his ardour or blast his career. Debarred from the prospect of earning further distinction in war, he devoted his energies to the good of the service and the improvement of his Corps."

His connection with the work to which he was to devote the next 29 years of his life, came about in the following way :—Although the necessity for a well-disciplined and instructed Corps of Sappers and Miners was not fully realized by the senior officers of the Engineers in the early years of the nineteenth century, the younger officers, who had been engaged for so many years on expeditions all over the world, were fully alive to the shortcomings of the Corps. As Pasley records :—"It had been deeply felt and lamented by those officers who had commenced their military career in the first war with the French Republic in 1793, and had afterwards served in Egypt and on other expeditions terminating in a less satisfactory manner. Young, or in the prime of manhood—full of enterprise and zeal, meeting and comparing notes together in the metropolis after the desultory expeditions in which they had served, and afterwards those employed in 1810 in the construction of the lines of Torres Vedras—meeting from time to time in some central spot, they excited in each other, and inspired their juniors with an *esprit de corps* and a devotion to the service of their Sovereign and country, that I do not suppose were ever exceeded. Capt. Charles Lefebure, who had served in the West Indies and in Holland, and had been the Commanding Engineer under Sir John Stuart in Calabria, afterwards unfortunately killed at Matagorda, near Cadiz, was at first the most influential of these officers. He it was who first pointed out to me and other officers, his juniors, as early as 1805, the inefficiency of the Corps for want of well-disciplined and instructed Sappers and Miners, which fatal experience afterwards proved to be too true. Of those employed in the Spanish Peninsula some years later, Capt. John Squire, a man of superior literary and

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classical, as well as of professional attainments, contributed most to keep up this noble spirit, and it was gratifying to me to find that our opinions on the state of the Corps, and on the management of the war always agreed."

Pasley writing again in 1809 says :—"The important Department in which I have the honour of serving, was so imperfectly organized, that I considered the British Army, though admirably adapted for battle, from the excellent discipline of the Cavalry, Artillery, Infantry, and Riflemen, or other light troops, was incapable of succeeding in a siege, though one of the most important operations of war, without either having recourse to the barbarous measure of incendiary bombardment, or without an enormous sacrifice of the lives of officers and soldiers in sanguinary assaults, which might be rendered unnecessary by a more efficient organization of the Royal Engineer Department, and especially in forming a well-instructed and a well-disciplined body of Engineer soldiers diligently exercised in all the operations of a siege, particularly in military mining; and also in the formation of military bridges. The better instruction of the junior officers of the Royal Engineers appeared no less essential, for at that time they were not even taught the theory of the attack of fortresses at Woolwich Academy. . . . As for practical instruction, they had none; for they were sent on service without ever having seen a fascine or a gabion, without the smallest knowledge of the military passage of rivers, of military mining, or of any other operation of a siege, excepting what they might pick up from French writers, of which a striking proof occurred in Sir John Moore's retreat, when all the attempts to blow up stone bridges, to impede the progress of the enemy, failed in affecting complete demolition, with the exception of one only, which Lieut. Davy, a very promising young officer, succeeded in completely destroying, but at the expense of his own life, which he lost from not understanding the very simple precautions necessary to ensure the safety of the person who fires the train of a mine. For my part I should not even have known how to make a battery in the attack of Copenhagen, the first siege in which I was employed, but for the information I derived from a French book on the subject."

Further, before the Walcheren expedition had taken place, Pasley sent in a report to the Earl of Chatham, then Master-General of the Ordnance, drawing attention to the inadequacy of the instruction given at the Royal Military Academy, Woolwich, and offering to submit to the loss of his commission if he failed to make good his charges against the system. Again, early in 1811, he appealed to the Earl of Mulgrave, the new Master-General, earnestly soliciting him to remove these defects in the instruction of the officers and soldiers of the Royal Engineer Department, as he anticipated great disasters in case any important siege should be undertaken if this were not done.

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Napier also describes the urgent need for such training in the British Army at this time in the following striking words :—" Without a Corps of Sappers and Miners, without a private soldier who knew how to carry on an approach under fire, they were compelled to attack fortresses defended by the most warlike, practised, and scientific troops of the age ; and the best officers and the finest soldiers sacrificed themselves in a lamentable manner to compensate for the negligence and incapacity of the Government, always ready to plunge the nation into war, without the slightest care of what was necessary to obtain success. The sieges carried on by the British in Spain were a succession of butcheries, because the commonest materials and means necessary for their art were denied to the Engineers."

The R.E. Department whose organization led to the above scathing criticism, consisted of the officers of the R.E., and of several companies of Military Artificers. A Royal Warrant dated 6th March, 1772, authorized the raising of the " Military Company of Artificers " at Gibraltar, and their strength was raised to two companies on the 30th June, 1786, both companies being stationed at Gibraltar. On the 10th October, 1787, six companies of " Royal Military Artificers " were raised, and were quartered at Woolwich, Chatham, Portsmouth, Gosport, Plymouth, and the Channel Islands. The two Gibraltar companies of soldier artificers were incorporated with the Corps of Royal Military Artificers in 1797. On the 1st September, 1806, the establishment was increased to twelve companies, the new stations being Dover, Cork, Gibraltar, the West Indies and Nova Scotia.

At the time that Pasley took command of the Plymouth company in 1811, none of these companies had been employed on active service, with the exception of the original " Soldier-Artificer Company "—as it was generally called—which was raised at Gibraltar in 1772 and employed at the siege of that fortress (1779—1783). The reason for the non-employment of the Royal Military Artificers is explained by Sir John Jones in his *Journals of Sieges in Spain and Portugal* in the following words :—" After a perusal of the foregoing journals, and observing how very much the want of Sappers and Miners prejudiced every siege operation in Spain, it will be learnt with surprise that, during the whole of the war, from 1793 inclusive, England paid, fed, clothed, and lodged a very large body of Engineer troops, legitimately Sappers and Miners. These, however, being designated the Corps of Royal Military Artificers, and composed chiefly of mechanics, were considered as more immediately intended for permanent works ; and the most limited number were reluctantly spared for field service, it being difficult to make it understood how mechanics could be required in any great number with an army. . . . The men were generally of superior requirements and well disposed ; but changing their officers incessantly, and their value

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being thought to consist altogether in their labour as mechanics, their discipline naturally became relaxed, and their habits irregular."

The chief reforms necessary were, it will thus be seen, three. 1st. To establish a closer connection between the Corps of Officers known as the Royal Engineers and the Corps of N.C.O.s and men designated the Royal Military Artificers. 2nd. To imbue the Royal Military Artificers with soldierly *esprit de corps*. 3rd. To train practically in field duties both the officers of the Royal Engineers and the N.C.O.s and men of the Royal Military Artificers.

Fortunately, after the two unsuccessful sieges of Badajos in 1811, urgent applications were made to the home authorities by Lord Wellington asking "that half-a-dozen companies might be selected from the Royal Military Artificers to be formed into a body under the name of Royal Sappers and Miners, that officers should be permanently attached to the companies so selected, and, after some instruction in their art, the six companies should be sent out to aid the troops in their future siege operations." Again, towards the close of the year 1811, this application was forcibly repeated.

These urgent representations from the seat of war, combined with Pasley's equally pressing letters at home, at last produced the desired effect and enabled him to write as follows in the third edition of *An Essay on the Military Policy of the British Empire*:—"The author sincerely congratulates his countrymen upon the hopes of a speedy improvement in one of the most inefficient departments of our military establishment; the defects of which have, for many years, filled his mind with constant apprehensions of the failure and disgrace, if not of the absolute destruction of some British Army."

A Royal Warrant dated 23rd April, 1812, was issued by H.R.H. the Prince Regent acting in the name and on behalf of King George III. authorizing an establishment at Chatham for the instruction of R.E. and Pasley (who after he had sufficiently recovered from his wounds to return to duty had been put in command of a company of the Corps of Royal Military Artificers at Plymouth Dock) was transferred from that station to start it.

Had he not been prepared with a remedy, the reform of the R.E. Department would, no doubt, have been delayed for a long period; but his powers of organization were at least equal to his critical ability, and he was ready with a cut-and-dried scheme for providing at the earliest possible date the trained Military Engineers so urgently required in the Peninsula. The most serious evils and inconveniences soon showed themselves inseparable from the system of having a Corps of Engineer Officers without any troops or even stores under their own immediate command, and who had to demand the former when required, from the Infantry, and the latter from the Artillery. In all armies it had been ultimately found necessary to attach a permanent body of non-commissioned officers and soldiers to the Engineer

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Department, as the experience of warfare fully proved, that however great the science or talents of any officers of Engineers were, their exertions in the field were in all cases much crippled, and were often liable to failure, unless supported by a proportionable degree of zeal, knowledge, and ability, on the part of the men, who acted under their immediate orders. It was the training of such N.C.O.s and men that proved one of the greatest difficulties Pasley had to contend with, and his system of overcoming it is best shown by the following extracts from the preface to his *Course of Instruction for the Use of the Royal Engineer Department* published in 1814 :—

"In the year 1811, having the command of Plymouth Co. of Royal Military Artificers, I was induced to embrace the opportunity which the conveniency of a Garrison life afforded, in order to ascertain by experiment the best and most practicable mode of improving the Corps in general in point of knowledge. It had long been considered desirable that the non-commissioned officers and soldiers should be able to understand the nature of a rough sketch, plan, or section. To this object my attention was consequently directed, but I soon discovered that the common methods of teaching practical geometry and plan drawing, were by no means calculated for the purpose in view.

After instructing one or two individuals of the most promising abilities, books and manuscripts were put into their hands, and they were employed to teach the others ; but although they themselves perfectly understood what they had learned, it was found that they were unable to communicate the knowledge which they had acquired. The reason of this is, that the common books of practical geometry, etc., leave too much to the discretion of the master, so that no man, however well qualified himself in this simple branch of learning, is capable of instructing a number of other men properly, unless he possesses a superior degree of judgment, a tolerably good education, and some experience in the art of teaching.

To have carried on a general system of the proposed species of instruction according to any of the books in common use, would therefore have required an establishment of regular mathematical masters. But it must be evident, that the difficulty of finding qualified persons willing to undertake this office, added to the liberal salary which men of education must have been entitled to, would have operated as almost insuperable objections to such an establishment.

To surmount these difficulties ; to lay down a course of instruction suited to the most untutored minds, and capable of being conducted by any man of good abilities, no matter how illiterate or ignorant in other respects ; in short, to establish a system of instruction, which might be perpetuated like the drill of recruits, by the exertions of steady non-commissioned officers employed as teachers, without the necessity of calling in the assistance of scientific masters of any kind :

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these are the points which I had in view in first commencing the present work ; and the success has fully equalled my expectations.

After the practicability of the system of instruction had been sufficiently ascertained by the improvement of the Plymouth Company, it was, by order of Lieutenant-General Mann, submitted to a committee of senior officers of the Corps of Royal Engineers in the month of March, 1812, and having been honoured by their approbation, it was soon after sanctioned by the authority of the Master-General of the Ordnance, and has since been conducted on a much greater scale at Chatham."

The next twenty-nine years of Pasley's life were spent in organizing and directing the School of Instruction at Chatham, the establishment of which followed so soon after his practical recommendation on the subject.

Mention has been made above of Pasley's *Essay on the Military Policy of the British Empire*. The first edition of this essay was published in November, 1810, the second in March, 1811, and the third and fourth in October, 1811, and November, 1812, respectively. The second edition of his Part I. had been described in the *Quarterly Review* for May, 1811, as " one of the most important political works that had fallen under the Reviewer's notice." There is reason to suppose that the reviewer was none other than the late Foreign Secretary, Mr. Canning, at that time in retirement from public life, consequent on his duel with Lord Castlereagh, arising out of the Walcheren Expedition. When this essay was first written it was described as Part I., as Pasley intended to round it off with a Part II., criticising British Military Institutions. So arduous were his duties however in connection with the foundation of the S.M.E. that he was never able to find time to leave us a review of our Military Institutions as they then were : he has done better in leaving us the complete reorganization of one. How effective this reorganization has been is best seen by comparing the efficiency of the Engineer branch of the British service in the Waterloo, Crimean, Egyptian and South African Campaigns, with the poor results achieved by it in the Peninsular War.

It was from such beginnings that the S.M.E. has gradually developed into the important Institution of to-day, with its wide range of subjects and numerous schools of instruction. Its efficiency and its undoubted influence on the training of officers, who, during the last 100 years, have had so large a share in both the extension and development of the Empire, are, not only, the best monument to the organizing genius of Sir C. Pasley, but they also give us good grounds for congratulation that its original foundation was entrusted to so wise a reformer, and that he was enabled to direct its destinies for so many years.

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MEMOIR.

MAJOR-GENERAL WILLIAM SPOTTISWOODE TREVOR, V.C.

THE death of William Spottiswoode Trevor on November 2nd recalls an historical period upon which the student does not care to linger.

Major-General Trevor, V.C., was the second son of Capt. R. S. Trevor, of the Bengal Cavalry, one of the party of three who were murdered with Macnaghten when he went out of cantonments at Kabul to conclude, as he thought, a treaty with the Afghan Chiefs.

William Trevor, a boy of ten, with Mrs. Trevor and his younger brother (now Sir Arthur), an infant in arms, were among the band who were detained in captivity by Akbar Khan for nine months in Afghanistan. The events of this captivity made a deep impression on Trevor and he carried through life the recollection of the scenes he had witnessed at that time.

He had been taught to read and write Hindustani and Persian and he used to relate how Akbar Khan endeavoured without success to avail himself of this knowledge to discover what was being talked about by the prisoners, and to induce him to translate letters received from India. A favourite amusement of Akbar's was to get up fights between Trevor and the Afghan boys, offering as prizes legs of mutton.

On their release from captivity by the avenging army, Mrs. Trevor and her two sons came to England and after a preliminary education at the Edinburgh Academy and elsewhere, William went to Addiscombe. Of this period of his career General Craster—who joined with him—writes :—

"W. Trevor did well at Addiscombe and in his third term was 1st in his term and became senior Corporal, but in his fourth term he was unwell during the final examinations and came out 3rd, Craster and Brownlow being 1st and 2nd. Owing to want of tact on the part of the authorities a spirit of great discontent sprang up during his last term, and Trevor's task as senior Corporal was made very difficult; but whatever the difficulties might be Trevor always, as he did throughout life, faced them bravely, and succeeded in overcoming them.

"On leaving Addiscombe Trevor joined the Royal Engineer Establishment at Chatham and during his stay there was employed on special duty under the Commissioners of the Great Exhibition of 1851. Arriving in India early in 1852—preparations were being made by Lord Dalhousie to send a man-of-war to Rangoon to demand reparation from the King of Burmah for his unjust treatment of our

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merchantmen at Rangoon, and for the imprisonment of some of their officers. Consequently all the young Engineer officers who had arrived from England were detained in Calcutta in case their services should be required. Eventually an expedition sailed under General Godwin in March, 1852, to which Trevor and three other young officers of Engineers were attached. On arrival of the expedition at Rangoon—where it was joined by a strong force from Madras—an attempt was made to communicate with the Governor, but the steamer conveying the messenger, was fired on and on the following day the stockades on the river in front of Rangoon were bombarded by the men-of-war and destroyed—on the 12th April, 1852, the troops were landed to attack the large stockade thrown up round the Rangoon Pagodas. The attack was cleverly opposed by the Burmese troops who occupied the tree jungle and outlying forts in great numbers, bringing a heavy fire of guns and muskets to bear on the attacking party of the 51st K.O.L.I., supported by the Madras troops. The advance was checked with considerable loss of officers and men—Donaldson of the Engineers was mortally wounded, Trevor's arm was broken by a bullet and several officers of the 51st were disabled.

"As it was most important that this stockade, which commanded the line of advance, should be taken without delay—Major Fraser, Commanding the Sappers, directed the Engineer officers to advance with their ladder parties, and a party of volunteers from the Royal Irish, to take the stockade—Fraser leading the attacking party. An advance was made under heavy fire, ladders were raised and Trevor was the first man to mount a ladder; the pain of his broken arm however caused him to fall from the ladder and prevented him from entering the stockade. But others followed and the stockade was quickly taken and cleared.

"General Godwin, in his despatch of 22nd April, 1852, wrote :—
Major Fraser, Commanding Engineer, has been indefatigable in his own department and indeed everywhere. . . . He has requested me to bring to the notice of the Governor-General in Council the gallant conduct of 2nd Lieut. Trevor. . . .'

"Trevor was sent back to the field hospital, put on board the hospital ship and sent with the wounded to Moulmein where he remained until his wound—a fracture of both bones—was healed. In the autumn of 1852 he had sufficiently recovered to join the expedition under Sir J. Cheape to Donabew where a noted leader had taken up a strong position and had repulsed a strong party of sailors with the loss of two of the naval guns. The advance, from the river to Donabew, lay for several miles through thick tree jungle, the Burmese from the shelter of the trees bringing a heavy fire to bear on the advancing troops. Their main position was a strongly placed earthen parapet protected by a deep wet ditch; the only causeway across which was defended by the two captured naval guns. As the

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storming parties advanced these guns were fired and swept away the head of the column; this occurred twice, when a third column was formed to which Ensign (now F.M. Lord) Wolseley and Trevor with other officers were attached. As they advanced the guns were again fired and Wolseley fell severely wounded. Taylor, a Madras officer, was also badly wounded. Trevor avoided the fire by advancing along the slope of the causeway and made good his way, through the parapet. Alone and concealed he watched the men who were again loading the guns and then shot them down with his revolver (being an expert shot). In this way he prevented the Burmese firing the guns again. The storming party was re-formed, and the place taken without further loss."

For his conduct on this occasion, when he was again wounded, Trevor received the thanks of the Government in a Notification dated 22nd April, 1853. On the conclusion of the war he was employed on the Pegu survey and later on the Bassein river with a view to making a sanatorium at the mouth of the river, which was to be called Dalhousie. The site however proved unsuitable and the project was abandoned. During these years his position was very insecure and one very serious attempt on his treasure was only averted by a timely and daring attack on a considerable body of marauders.

In October, 1857, Trevor was transferred to Bengal and sent to Darjeeling to construct barracks for the European soldiers on a site at Senchal which had been selected by Craster under the orders of Colonel R. Napier. Here he found the only opportunity of taking part in the operations connected with the mutiny, by accompanying the "Darjeeling Field Force," under Capt. The Hon. E. Curzon, H.M. 52nd, to intercept the mutineers of the 75th N.I. from Dacca who were endeavouring to join their comrades at Julpigoree, and with whom they had an engagement at Cherabunder on the Bhutan frontier. Following on the construction of the barracks at Senchal, he was employed on the construction of the Ganges and Darjeeling Road. This occupied him till April, 1861, when he was appointed Garrison Engineer at Fort William. About this time he undertook the design and laying out of the Eden Gardens in Calcutta by converting a tract of waste land on the bank of the Hooghly into an attractive pleasure resort. In this he seemed to have a natural bent and the work laid out with so much skill and taste was completed by his brother, S. T. Trevor, who succeeded him. In February, 1862, he officiated as Superintending Engineer of the Northern Circle and under his superintendence the "Ganges and Darjeeling Road" was completed to the foot of the mountains, and the mountain road in continuation to Darjeeling laid out, and partly executed. It was during these years that Trevor became critical of the manner in which accounts in the Public Works Department were being carried out. He formed the opinion that they were too harassing to

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the Engineers, and did not sufficiently represent the progress of the work, and he endeavoured—not without resistance from those responsible for existing methods—to obtain adhesion to his views. In May, 1863, he was called upon to assume the office of Controller of accounts—a complete justification of the views he had advocated.

During this period, he assisted at a special inquiry in the Railway Department and also for a short time took charge of the Calcutta mint and in February, 1865, his services were placed at the disposal of the Military Department for service with the Bhutan Field Force, and here he found the opportunity for gaining the distinction most prized by soldiers. The attack on Dewan-Giri has been told in many ways, but without entering into such details as would require illustration with a plan, it will be sufficient to say that the position was a gorge defended by two blockhouses, one large and one small; a house called the "Guru Lamas" and a stone entrenchment in advance. General Tombs in his despatch of 7th April, 1865, after describing the preliminary steps and the expulsion of the enemy from the stone entrenchment, writes: "It was at this moment that I sounded the advance, covered by the fire of the rifles of the 55th in the stone entrenchment, and whom I had ordered to remain there for that purpose. . . ." The remainder of the story is succinctly told in the War Office Notification conferring the Victoria Cross:—

THE VICTORIA CROSS.

(From the *London Gazette* of last night).

WAR OFFICE, DEC. 31.

The Queen has been graciously pleased to signify her intention to confer the decoration of the Victoria Cross on the undermentioned officers, whose claims to the same have been submitted for her Majesty's approval, for their gallant conduct in Bhootan, as recorded against their names, viz.:—

Royal (late Bengal) Engineers.—Major William Spottiswoode Trevor and Lieutenant James Dundas—For their gallant conduct at the attack on the Block-house at Dewan-Giri, in Bhootan, on the 30th of April, 1865. Major-General Tombs, C.B. V.C., the officer in command at the time, reports that a party of the enemy, from 180 to 200 in number, had barricaded themselves in the Block-house in question. which they continued to defend after the rest of the position had been carried, and the main body was in retreat. The Block-house, which was loop-holed, was the key of the enemy's position. Seeing no officer of the storming party near him, and being anxious that the place should be taken immediately, as any protracted resistance might have caused the main body of the Bhooteas to rally, the British force having been fighting in a broiling sun on very steep and difficult ground for upwards of three hours, the general in command ordered these two officers to show the way into the Block-house. They had to climb up a wall which was 14 feet high, and then to enter a house, occupied by some 200 desperate men, head foremost

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through an opening not more than two feet wide between the top of the wall and the roof of the Block-house. Major-General Tombs states that on speaking to the Sikh soldiers around him, and telling them in Hindoostani to swarm up the wall, none of them responded to the call, until these two officers had shown them the way, when they followed with the greatest alacrity. Both of them were wounded.

Trevor's own version was that at the critical moment when the storming party hesitated to attack, Tombs turned round to him and said "Will no officer give the men a lead?" Trevor said "I will, sir," and throwing away his scabbard he took his sword in his teeth and with Dundas proceeded to climb the stockade with a shower of stones falling on them and cutting them. On reaching the interior of the stockade, Trevor was badly wounded from below by a spear thrust before he had received assistance but here his revolver served him in good stead and he was able to counter any further attack with deadly effect until others coming in resistance ceased. Referring to Trevor in his despatch Tombs wrote: "Trevor is an officer not only of great talent but of rare coolness and courage."

In Vibart's *Addiscombe: Its Heroes and Men of Note* the following extract refers to this episode :—"How Trevor and Dundas escaped death was a marvel. Perhaps the restricted space at the point of entrance had something to do with their success; the defenders being unable to use their swords effectively; and getting jammed in their eagerness to close with them" (pp. 372, 5), and, it may be added, to the fact that the defenders on the gallery were only armed with a cutting sword.

Trevor was suffering from illness at the time of the attack and was afterwards sent back to Gowhatty for treatment, after which he took leave and on his return became Superintending Engineer at the Presidency. During his superintendence many important Public buildings were constructed. He again took leave in 1870 and during that time saw a good deal of the earlier phases of the Franco-German war of which he had many amusing stories to tell.

On his return to Calcutta he found that in consequence of settlement in the foundation of the new High Court some uneasiness was felt as to the construction of large buildings on the soil of the Delta of the Ganges, and he conducted experiments and made elaborate calculations to determine the pressure that could safely be applied to such foundations. In 1874 he was appointed special Chief Engineer for the Famine relief works north of the Ganges and received the thanks of Government for his services, in connection with those operations. After this he assumed for a time the duties of Inspector-General of Military Works; in January, 1875, he was transferred as Chief Engineer to Central India and in December of the same year was appointed Chief Engineer of British Burmah, a post he held till 1880. Here he was principally concerned with the organization of

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the Department and the preparation of schemes for future work ; the defences of Rangoon and of the Railway from Prome to the frontier were also considered. Before leaving Burmah his services were required by the Government of India to assist in drawing up a scheme for the re-organization of the Engineer establishment for which he received the thanks of Government.

In February, 1882, Trevor was appointed Secretary to the Government of India in the P.W.D., a post that he held for five years retiring from the service in February, 1887, with the rank of Major-General. The duties of a Secretary to Government are of a confidential nature and necessarily excluded from notice in this memoir. His work during these years is contained in the records of the Government of India, with one interruption when in July, 1882, he was invited to make a professional inspection of the Corps of Sappers and Miners. His report, which was suitably acknowledged, was considered conclusive as to the satisfactory condition of the Corps. His early and lifelong friend General Craster who has so faithfully recounted Trevor's service in Burmah, while modestly concealing his own conspicuous share in that episode, writes : " He was a firm friend always ready to uphold the right, regardless of any consequence to himself with a clear brain which enabled him to see clearly to the bottom of a subject and to detect all fallacies that enveloped it."

General Brownlow another lifelong friend writes : " Morally and intellectually he was a grand man, upright, fearless, broad-minded and modest." Similar testimony could be gathered from without as well as within the Corps. No man had more or truer-hearted friends and it may be safely asserted that he never made an enemy.

After his retirement Trevor kept up his mathematical studies and devoted much time to solving the problem of the best form for a projectile. He had been an extensive reader, especially of history and science, and having a retentive memory and a faculty of digesting and analyzing what he had read his conversation on any subject was always interesting and instructive ; and his daily visits to his club were looked forward to by a large and now rapidly decreasing circle of friends, to whom he would at times, with characteristic humour and by way of illustration to the subject matter under discussion, recount some incident in his eventful life that would have lent interest to a biography ; but which are now unhappily lost.

It has been said in a recent notice (*Pioneer Mail*, November 15th) that " Had fortune allowed him to be with the Delhi or Lucknow forces during the Mutiny, he would, no doubt, have made his reputation as a soldier rapidly, having every qualification for eminence in the profession of arms—strong mental capacity, decision of character, a daring spirit and a robust frame ; but he was employed in Lower Bengal when the rebellion broke out and could not succeed in getting

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to the front. His turn came in the Bhutan campaign where he led the assault on Dewan-Giri and should have been infallibly killed but escaped with a number of wounds and the Victoria Cross. In 1870 he saw a good deal of the earlier phases of the war from the German side. He had no introductions but managed to get to the front for a time by taking the place of a special correspondent who had been sent out knowing nothing of the business and was quite content that Colonel Trevor should see the fighting while he got the credit of the descriptions. . . . By those who knew him personally he will always be remembered as a man who might have been anything as a soldier if circumstances had been more generous to him in the way of opportunities." This is indeed true for he had all the instincts of a soldier, and—under an unassuming manner—rare courage and determination. He was a deadly shot with a revolver—to which on several occasions he owed his life—and an expert swordsman. More than once in his young days, it occurred that some one who fancied himself with either foil or sword learnt from Trevor the lesson he thought to teach. The Calcutta Tent Club knew him as a daring rider even among men of lighter weight and better mounted than himself. But his was a many-sided character and in more ways than one will William Trevor be remembered.

Those who served under him, and whom he inspired to a remarkable degree, with a feeling of affectionate loyalty, will recall his readiness to give advice or assistance to help anyone whose heart was in his work, and the chivalry of his nature in awarding praise that he might have appropriated to himself. Those associated with him later in public life in his own immediate profession will remember his unerring judgment; his determination to uphold the right fearless of any consequences to himself, and his desire to combine the lessons of experience with the deductions of scientific inquiry. Those in the wider circle of Administration will remember him as a man whose opinions were always worth having, and whose contributions on such different subjects as the re-organization of the Indian Army, the Public Works Department, the Currency, the defence of our frontier and the purchase of Guaranteed Railways by the State were always interesting and in some cases helped to shape the policy of the Government. To the friends of his later years the most pleasing reminiscences will perhaps be the extent of his knowledge, the charm of his conversation and the warmth of his friendships, and they will note, with a sense of personal injury that the Government he served so well, allowed him to go to his grave without any other decoration than that which he earned at the cost of a lifelong injury.

He married in 1858 the daughter of the Rev. H. Fisher, of the Indian Ecclesiastical Department, who died in 1863, and leaves one daughter married to Colonel Brackenbury, R.E. To her the memory of such a father will remain a priceless possession.

J. P. STEEL.

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TRANSCRIPTS.

THE USE OF ENTRENCHMENTS AND FIELD FORTIFICATION IN THE ATTACK.

By MAJOR E. J. M. WOOD, 99TH DECCAN INFANTRY.

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ALTHOUGH there is abundant evidence from works still existent that entrenchments and field fortification were employed and their advantages thoroughly understood in the remote ages when primitive man fought with primitive weapons, it is equally evident that they were utilised solely in the defence, and their employment considered as incompatible with the freedom and activity required from the attacker.

Later on, when war had developed into a science, armies become more mobile, and weapons more accurate and long-ranging, it came to be recognised that field fortification, though a valuable and in fact indispensable adjunct to a successful defence, was nevertheless but a means to an end and that, in order that a complete success be obtained, the assumption of the offensive, at some period of the fight, on the part of the defender was essential. It was, however, a very long time before this fact was fully recognised, and defences long continued to be constructed in such a manner as to offer as great an obstacle to an advance by the defenders as to an assault by the attackers.

The advantages of the Offensive—Defensive once recognised, field fortification came to be relegated to its proper sphere, as an auxiliary only, and not the main desideratum to the successful defence of a position.

It is only in very recent times that it has begun to be recognised that field fortifications and entrenchments may likewise prove a most valuable auxiliary in the attack. The whole idea of field fortification, or what was an almost synonymous term—"field defences," seemed to negative any connection between them and the attack. Not that the value of what has been termed "aggressive fortification" has not been recognised on occasions, for it was employed as long ago as the American Civil War and the Russo-Turkish War of 1877; while in the Franco-German War, there were several instances of its use – notably at the Battle of Mars la Tour, where the Prussians in their attack, having gained possession of Vionville, promptly proceeded to entrench, and so strengthened their position in that village that, in spite of the desperate attempts of the French to retake it, it remained in their hands and formed a valuable *point d'appui*.

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Thus here and there scattered examples may be found of the employment of field fortification by troops acting on the offensive, but it has been left to the South African and Russo-Japanese Wars to demonstrate that the spade is second only to the rifle in the winning of battles, and that on the modern battlefield it is almost of as great value in the attack as in the defence.

It would seem advisable before proceeding further to explain what is no doubt meant to be understood by the expression "in the attack" in the sentence which forms the subject of this essay. It has of course no reference to the deliberate attack on a fortress, or a position so strongly fortified that the attackers are compelled to sit down to a deliberate siege, as the Russians were eventually compelled to do before Plevna.

The necessity for entrenching and fortification in this kind of attack has always been recognised, and the approach, by means of trenches, redoubts and parallels, pushed gradually nearer until the time for the final assault, has been the normal procedure from the earliest times, but this species of entrenching hardly comes within what is usually known as field fortification. On the other hand, it is not restricted to the typical "attack," *i.e.*, an advance on a defined position by an attacker culminating in an assault and bayonet charge, for it may be held to include all those various tactical movements contemplated in attacking an enemy in position, which are referred to in section 110 of *Combined Training*, where the best type of an offensive battle is defined as "a methodical progression from point to point, resolving itself into a series of distinct engagements each raging round a different locality and each protracted over many hours." The expression too, no doubt, is meant to include offensive action on the part of the defenders, and all the "variations in a combat which resolve themselves into attack and defence."

With regard to the selection of the "recent wars" from which to seek for examples of the use of entrenchments and field fortification in the attack, it seems superfluous to look further than those already referred to, viz., the Boer and Russo-Japanese Wars. In both these campaigns rifle and cannon had reached practically to their present state of perfection as regards range, accuracy and rapidity of fires, the conditions as regards armament were therefore as nearly as possible the same as will obtain in the future, at any rate for some time.

The very extensive use of the spade by the Japanese with such good results to themselves furnishes an example such as could be obtained from no other campaign, while the many occasions during the Boer War on which we failed, owing to lack of experience to realise the value of entrenching in the attack may be held to furnish an equally valuable object-lesson.

It next remains to decide on the best method of deriving instruction from these wars as to the various uses to which, and the circumstances under which, entrenchments and field fortification may be usefully employed in the attack. It is considered that this could be best achieved by taking one by one, the different uses to which entrenching in the attack may be put, as gathered from a study of these campaigns, and illustrating each one by examples of occasions when they were actually

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employed with advantage, or when they might and should with equal advantage have been so employed.

In describing the various methods of employment the principle has been followed of taking them in the order in which they would usually be adopted, from the initial stages of a battle up to the final assault. No doubt some of these uses, which have been classed separately, might come under one heading and, in some cases, they naturally merge one into the other, but for the sake of clearness and illustration it seems better to keep them thus separated. They are as follows:—

VARIOUS USES OF ENTRENCHMENTS IN THE ATTACK, WITH EXAMPLES.

The Construction of Entrenchments by an Attacking Force in Anticipation of an Advance to Attack, either to serve as a "Point d'Appui" or upon which to fall back in Case of a Reverse.

A good illustration of this is furnished by the Japanese preparations prior to the action at Yushiu-lin, fought on the 31st July, 1904. On the 19th July, the 12th Division of the 1st Japanese Army had defeated the Russians and driven them out of their position at Chao-tao. On the night of the 20th July General Inouye, under cover of his outposts, set to work to dig a line of entrenchments about 2,000 yards beyond the Chao-tao position, and about 3,000 yards from a position at Yushiu-lin beyond which the Russians had retired, but which from its nature was unsuitable for occupation by the Japanese.

These entrenchments were made right across the valley leading from Chao-tao to Yushiu-lin, and the General's intention in making them was doubtless—(*a*) to have a good *point d'appui* or starting point for an attack on the Yushiu-lin position, and (*b*) to have good cover to rally on in case such an attack should fail, there being no natural cover anywhere in the valley, as far back as Chao-tao, from guns on the Shisan Ridge (part of the Yushiu-lin position).

These entrenchments had small trenches in advance of them for double sentries at night; they thus in addition afforded good protection for the outpost line, and kept back the enemy's reconnoitring parties; the whole were concealed from the enemy by the kaoliang fields. The attack by the Japanese on the Russian position at Yushiu-lin did not take place until the 31st of July, so this preliminary entrenching was carried out over ten days before the actual attack.

The battle of the Sha-ho furnishes another example of this use of field fortification. The Japanese had become aware that the Russian forces in front of their right, viz., that portion held by the 1st Army, were being strongly reinforced, and Marshal Oyama, divining their intention to turn his right flank, had resolved to make a counter-move against the whole Russian front as the best means of defeating the scheme.

On the 24th September the 2nd Division of the 1st Army was advanced and ordered to entrench itself along a position north of the Yentai coal-mine, with its right in the valley of Daisan and its left near the village of Hakoreishi. The trenches were elaborately prepared with head cover

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made by notches in the parapets, and traverses for protection from enfilade fire, while bombproof shelters constructed of logs roofed with sods were provided every few yards. In addition, positions were entrenched for the batteries, with bombproof shelters for the detachments. These elaborate entrenchments must have taken some days to make, and there can be no doubt, were constructed to form a starting point from which this Division should commence their forward movement, as well as to serve as a rallying point in the event of this forward movement being repulsed, or perhaps to enable the Division to hold its ground should the Russians attack before the Division was ready itself to advance.

On both these occasions the Japanese did not hesitate to expend a tremendous amount of trouble and labour on entrenchments which might possibly never be used, but their doing so is in keeping with their careful deliberate methods throughout the campaign. As a matter of fact the Russians did make an advance towards the position on the 10th October, about a fortnight after the entrenchments had been constructed, and shelled the Japanese batteries, which, however, were too well entrenched to suffer; the Russian infantry also made a show of advancing but never came within rifle range. On the night of the 10th October the 2nd Division emerged from their trenches and assumed the offensive.

An example of an occasion when field fortification, under similar conditions, might have been employed with advantage is furnished by the battle of Colenso in the Boer War. The attack on the Boer positions along the Tugela near Colenso had been contemplated by General Buller some time before it actually took place; the ground south of the river over which the troops were to advance to the attack was absolutely open for miles in front of the excellent cover afforded to the enemy by the kopjes and hills on the north bank. It would have been of enormous advantage to have had a line of entrenchments, with good cover for guns, constructed within about 3,000 yards of the river, under shelter of which the troops could have been concentrated at a comparatively short distance of their objective, and which, as the event showed, would have been the saving of the situation, in providing a rallying point behind which they could have retired when the unexpected strength of the Boer position was disclosed.

Here there could have been a reorganisation and re-forming of the troops, after which a renewed attack could easily have been made, aided immensely by complete information of the enemy's strength and dispositions. With such a position the recovery of the abandoned guns would have been a certainty. Nor should there have been any difficulty in executing such entrenchments, for had the Boers attempted actively to interfere with the work they would have had to assume the offensive and completely disclose their own dispositions, neither of which proceedings would have at all suited their plans, while the naval guns could easily have kept down any fire from the Boer long range guns, had the latter considered it worth while to shell the working parties. The work too could have been carried on entirely at night, if it had been found necessary or desirable.

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The advisability of some such preparation seems to have been impressed on General Buller by his subsequent operations against the Boers, for, prior to his final and successful advance to the relief of Ladysmith by means of an attack on the Boer positions south of the Tugela, he on the 14th February took up a position along the Hussar Hill heights with Lyttelton's Division on the right, Warren's on the left, and the mounted troops on both flanks, and entrenched. The actual advance from this position was not made until the 17th.

It is obvious that this use of field fortification would not be desirable on occasions where surprise forms the main consideration, but this does not detract from the advantages to be derived from its employment under suitable circumstances.

2. *The Construction of Cover for Artillery.*

The long range and marvellous accuracy of modern artillery makes it imperative that artificial cover be provided for guns in future in the attack as well as in the defence; there can be no more trotting or galloping into action and unlimbering under the enemy's fire; such action would mean annihilation before a shot was fired. The Japanese recognised this fact at once, and it was only on very rare occasions throughout the war that their guns opened fire without first providing shelter for the detachments; as a rule gunpits or epaulments were most carefully prepared before a shot was fired, and cover provided for everyone, officers included. This entrenching was carried out both prior to and during an attack.

(*a*). *Before an Attack.*—The Russo-Japanese War furnishes many examples of this. At the very first battle of the war the Japanese took the precaution to provide beforehand artificial cover for their artillery. On the night of the 29th April, 1904, positions for their howitzers, from which the Japanese hoped great things, were very carefully prepared and thoroughly entrenched on the island of Kin-tai-to in the River Yalu, and everything possible was done to conceal them. The fire from these howitzers on the Russian position at Chiu-lien-cheng was most telling, and no doubt it was largely due to it that the Japanese infantry were able to cross bare ground and ford a bad stream in the face of fire of infantry entrenched only 800 or 1,000 yards away, while so effectively were they concealed and protected that no Russian shells fell even in their vicinity; the gunners were thus able to maintain their fire undisturbed by the enemy's shells.

Again at the action at Yushiu-lin on the 31st July, 1904, the Japanese prepared positions for their artillery close to the entrenched position previously referred to, but, whereas the position had been prepared days beforehand, the cover for the guns was only constructed on the night immediately preceding the attack, in order that the Russians should have no idea of their whereabouts. Here again the cover was most carefully prepared with good rear and lateral communications. The result justified the precautions, for again the Russians were unable to locate the Japanese guns, which suffered very little in consequence.

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It was not always possible for positions for the Japanese guns to be prepared with so much care; at the action of Chao-tao on the 19th April, 1904, they only took up the positions assigned to them just before daybreak, but all the same they hastily entrenched before opening fire.

The occasions during the war when cover for artillery was constructed beforehand by the Japanese were numerous, it was in fact their invariable custom whenever possible to select the positions for the guns by daylight and construct the epaulments, etc., after dark, the guns being placed in them before dawn.

This practice might have been followed with advantage more frequently than it was in the Boer War, though no doubt the knowledge of the numerical inferiority of the Boer artillery led to the neglect of such precautions. On one occasion at least, however, the results obtained by the placing of artillery in position beforehand were such as to thoroughly commend the practice. This occasion was Buller's attack on Botha's Pass on the 8th June. On June 6th the South African Light Horse seized Van Wyk's Hill, a prominent feature opposite the Pass, and after reinforcement by Coke's Brigade repulsed a bold attempt of the Boers to retake it. That night with great difficulty some heavy guns were brought up on to the hill whence they could command the Boer position on the summit of the Pass. During the 7th June more heavy guns were placed on advanced features more or less commanding the Boer positions. It was not until June 8th when a large number of these long range guns had been got into position and were ready to open fire that the attack on the Pass commenced.

As a result of the fire of these heavy guns the Boers were unable to occupy their trenches along the crest, and the infantry were thus able to advance up the steep slopes of the mountain practically unmolested, and when they had once reached the crest the Boers made but a short fight before retiring.

The capture of the Pass would have been a very different matter had not the artillery by its fire from these carefully selected and prepared positions driven the Boers away from the crest.

(*b*). *During an Attack.*—The great duration of many battles in the recent war, when for day after day the Japanese pushed their advance against the Russian positions, afforded many opportunities of constructing cover for artillery during the attack. In the majority of cases advantage was taken of the cover of darkness to prepare these positions, partly on account of the great difficulty of entrenching under fire, and partly that, under modern conditions, it is a highly risky proceeding to move guns from one position to another within range of the enemy's artillery, except of course the change under cover from one previously prepared position to another, and consequently the guns were not often moved in daylight.

At the battle of the Sha-ho the Japanese began their forward move on the 10th October; resistance was stubborn, the fight for the possession of each village held by the Russians constituting a separate struggle with attack and counter-attack.

During the 12th October the 6th Division, 2nd Japanese Army, had failed to make much progress and General Oku resolved to push on

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under cover of night, and attack with that Division at dawn the villages of Erh-shih-chia-tsz and Hsiao-tung-tai; the 6th and 13th Regiments of Artillery were accordingly advanced after dark, took up entrenched positions whence they could effectively cover the infantry attack, and opened fire directly daylight dawned.

These guns were largely instrumental in bringing about the success of this attack.

Similarly in the case of the 3rd Division, 2nd Army. On the night of 11th October this Division was in occupation of the village of Hsiao-chien-kou, which they had captured after severe fighting just before sunset; preparations were at once made for the advance next day, and the artillery of the Division, together with some guns previously captured from the Russians, took up positions to cover the further advance.

These positions were as usual most carefully prepared with deep trenches for the detachments as well as pits for ammunition wagons and the guns moved into them before daylight.

The above are examples of cover for artillery constructed during the attack by night, but when compelled to advance their guns by daylight the Japanese invariably prepared cover for the detachments before opening fire.

At the battle of the Sha-ho on the 12th October the Russians were retiring at about 10.30 a.m. from the Shotatsuko valley; the Japanese artillery of the 2nd Division were too far off to do much damage so advanced; before firing a round, however, the gunners set to work to dig up cover. This caused some delay and the opportunity afforded to open fire on the excellent target offered by the retiring Russian infantry was to a certain extent wasted. Again on the same day about 4 p.m. three field batteries were moved up to a position close to the hill of Tera-yama, but did not open fire until they had spent half an hour in digging gun-pits. Directly they did open fire they were located by the Russian gunners who directed rafales at them; this fire had the Japanese batteries been unentrenched would speedily have silenced them.

At the battle of Mukden on the 2nd March the 5th Regiment of Mountain Artillery was detailed shortly after 1 p.m. to cover the attack by the 5th Japanese Division on the village of Chou-kuan-pu; it accordingly came up under cover of a village, and the gunners at once set to work making emplacements for their guns along the east side of this village. No guns were brought up until the emplacements were all completed, and fire was not opened until 2.45 p.m.

It may be maintained that this reluctance of the Japanese gunners to open fire without first entrenching was apt to lead to delay at important junctures and the loss of valuable opportunities; this was the case on the occasion above referred to; but having regard to the rapidity with which unprotected guns can be placed out of action by the fire of modern artillery, the circumstances would have to be very urgent and exceptional to justify guns disclosing their positions by opening fire before some cover had been prepared.

That the Japanese recognised that there were occasions on which cover for artillery could and should be dispensed with is shown by the fact that, after the pursuit of the Russians began on the 8th March after the battle

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of Mukden, the Japanese batteries did without cover, everything being sacrificed to the necessity of causing as much damage to the retreating enemy as possible, while the risks involved were of course proportionately less.

In the South African War, as has been said, the numerical inferiority of the Boer artillery rendered the elaborate preparation of cover of less importance, and guns were frequently moved from one position to another in the daytime and within range of the enemy's guns without incurring serious risk, though this did not always hold good. Experience, however, showed that the value of good cover was by no means to be ignored. During the operations on the Tugela which led to the relief of Ladysmith, Lyttelton's Division was ordered to carry out an attack on the Boer position at Monte Cristo at dawn on the 18th February. In order to provide artillery support for this attack the guns of the 64th Battery were dragged up on to a knoll half way up the Cingolo Nek, and the gunners, aided by the Devons, spent the night in getting the guns into position and erecting emplacements for them.

The guns so placed were of the greatest value in covering the infantry attack on Monte Cristo Hill.

Reference has been made to the desirability of recognising that the preparation of cover for guns must be subordinated to the necessity of not losing an opportunity of opening fire on a target which is likely to repay the risk incurred. An example of this was afforded during these same operations on the Tugela. On the 18th February the Boers, on being driven from their position on the line Green Hill—Monte Cristo, began to retreat from their position on the left bank also. Two naval guns were brought up to the top of the Monte Cristo Hill about 3 p.m. on the 19th, whence some of the retreating Boer laagers offered an excellent target; they, however, waited to make epaulments before opening fire and the opportunity was thus lost.

3. *The Construction of Entrenchments after an Advance made under Cover of Darkness.*

This method of utilising field fortification will certainly be extensively employed in future wars. It seems to be universally recognised that, in order to get within such a distance of an enemy's position as will offer some reasonable probability of an attack on such position being successful, especially in the case of a frontal attack over exposed ground, there will have to be an advance under cover of darkness followed by a vigorous offensive at daylight.

The desirability of having some cover at the point thus reached as a protection from the fire, which the enemy is sure to concentrate on the attacking force immediately daylight makes him aware of his presence and enables him to aim with accuracy, is sufficiently obvious, while trenches so constructed will afford the attackers a definite line to hold on to, from which they can resist the enemy's attempt to drive them back by counter-attack, and behind which, if their assault be repulsed, they can rally for further efforts.

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The examples of this use of field fortification were very numerous in the Russo-Japanese War. In the attack by the Russians on the Motienling Pass on the 17th July they entrenched themselves before dawn along the wooded ridge south of the old temple, which they had reached in their night advance.

The attack by the 45th Regiment of Japanese infantry on the village of Erh-shih-chia-tsz during the battle of the Sha-ho is another conspicuous example. This Regiment formed the left of the 6th Division, 2nd Army; the village of Yang-chia-wan, distant about one mile from the above village, had been captured from the Russians about 3 p.m. on the 11th October, but attempts to advance further were unsuccessful. General Oku accordingly decided to advance after dark; the objective of the 45th Regiment was the village of Erh-shih-chia-tsz which formed the right of the Russian position on the Shih-li-ho. The 1st Battalion of the Regiment was to work up the right bank of the Sha-ho, the other two battalions up the left bank, one battalion in the first line and one in the second.

The 2nd and 3rd Battalions moved out of Yang-chia-wan about 8 p.m., but had only gone about 600 yards when the leading battalion was fired on; it promptly halted and began to entrench; on the enemy's fire ceasing the advance was resumed, but this time the leading battalion had only advanced about another 200 yards before it was again hotly fired on, whereupon it halted and again entrenched and scouts were sent out.

The battalion managed to push on for another 150 yards, where it was within about 600 yards of the enemy's position; here a third line of trenches was dug and completed before dawn. By this means the battalion had by daylight established itself in a good entrenched position only 600 yards from their objective and with very little loss. The 1st Battalion similarly worked forward under cover of the river bed; on its reaching the stream which flows into the Sha-ho to the west of the village of Erh-shih-chia-tsz it was discovered by the enemy and fired on; it thereupon halted and dug entrenchments. On the fire slackening it again advanced in a more easterly direction for another 300 yards; here the firing line halted and set to work to dig and by daylight had completed their trenches. They were now in position on the flank of the Russians and within a comparatively short distance, and between 10 and 11 a.m. this battalion, with the other battalions of the regiment, carried the village by assault.

Had Colonel Carlton's men not been deprived of their entrenching tools by the stampeding of the mules on reaching Tohrengula Hill, or if they had had more practice in the construction of cover, the Nicholson Nek's disaster might have been avoided or minimised.

The battle of Colenso has been quoted as an instance when Method 1 of utilising field fortification in the attack might have been employed with advantage; an advance by night and the construction of entrenchments before dawn would have been of equal advantage, the advance being made from the entrenched position referred to in 1, or if this had not been prepared, from the camp.

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The actual use made of this method of advance at Paardeburg is perhaps more instructive than the object lesson afforded by its omission at Colenso. The close approach to the Boer laager, which had offered so much difficulty and cost so many lives on the 18th February, was accomplished subsequently by the gradual pushing forward of entrenchments at night without loss of life. That this advance was so slow was due to the fact that it was understood that the Boers were trapped, that there was no hurry, and that casualties were not to be risked. The final advance by the Canadians affords an excellent example of this use of entrenching in the attack.

The six companies detailed for the enterprise were formed up in two lines, the first with fixed bayonets and the second carrying picks and shovels; they were accompanied by some engineers to help in the entrenching. At 2.15 a.m. on the 27th February the companies moved forward from the point, distant about 600 yards from the Boer trenches, to which the British entrenchments had already been made. For nearly 500 yards they advanced undetected, then a furious fire was opened on them, the front line threw themselves down and opened fire, while the second set to work to dig, and for two hours continued digging covered by the fire of the other line. When dawn broke the companies were in the entrenched position within ninety yards of the enemy, and enfilading the whole of his trenches parallel to the river. The Boer surrender immediately followed.

There is little doubt that had this bold action been imitated by all the enveloping troops at a much earlier date it would have met with success, though not perhaps without incurring some losses.

4. *The Construction of Cover for Troops covering the Attack.*

It is one of the recognised principles of an attack on a position that the advance of the firing line, or portions of it, should be covered by the fire of other portions of the force. In many cases it is possible to arrange beforehand for this covering fire by some of the attacking troops from a suitable position. It is obvious that if these troops can be protected by entrenchments from the enemy's long range or artillery fire, they will be able to shoot with far greater care and accuracy than if exposed to fire in the open. This entrenching should preferably be done under cover of darkness, but it may often have to be made hastily in the daytime and even under the enemy's fire. At the battle of Liao-yang the 18th Regiment of Japanese infantry, forming part of the 3rd Division, 2nd Army, was ordered to carry out an attack on the hill known as "Rocky Ridge" situated to the east of the Shou-shan-pu Hill; the assault was to take place at dawn on the 3rd August, and the Regiment marched out at 3 a.m.; the three battalions were disposed as follows:—

1st Battalion—To cover the attack from a ridge to the east of the hill which formed the object of the attack.
2nd Battalion—Firing line and supports.
3rd Battalion—Reserve.

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The 1st Battalion sent two companies to a point on the ridge, from which they could bring a fire to bear on the enemy's position on Rocky Hill, where they entrenched. Although the attack on the hill failed these companies of this covering battalion, thus entrenched on the ridge, were able to greatly assist their comrades of the other battalions, both when making their desperate attack on the hill and later when they were checked and lying in the open behind such cover as they could scrape up.

During General Buller's operations for the relief of Ladysmith, in the attack on Monte Cristo by the 2nd Brigade on the 18th February, arrangements were made for covering the advance by long range rifle fire; for this purpose some companies of the Queen's and West Yorkshires and some Maxims were placed on the northern crest of Cingolo and on the slope of the Cingolo Nek. These troops took up their positions under cover of darkness, and were able to entrench themselves before opening fire at dawn. Their fire was most effective in keeping down that of the Boers from Monte Cristo during the crossing of the open Nek by the attacking companies.

5. *The Construction of Entrenchments under Shelter of which to form a Strong Firing Line, and from which to bring an Overwhelming Musketry Fire on the Enemy's Position prior to the Assault.*

The establishment of a strong firing line in good fire positions within decisive range is one of the principles laid down for the successful carrying out of an attack on an enemy in position. The building up of this firing line is a matter of great difficulty. The Japanese endeavoured to overcome this difficulty by digging trenches at night, and massing troops in them ready to bring an overwhelming fire to bear on the enemy's position at dawn. Examples of entrenchments made under similar conditions have been quoted in Method 3. Perhaps a clearer illustration of this particular use of field fortification is furnished by the desperate efforts of the Japanese to adopt the same tactics at the battle of Mukden, when the frozen state of the ground rendered any attempt at digging almost hopeless. The 8th Division, 2nd Army, on commencing its forward movement in conjunction with the other Japanese armies on March 1st, 1904, was ordered to attack the Russians in the village of Yueh-pu-tsz, this village formed a portion of the Russian defences which they had been holding since the battle of the Sha-ho. During the night, digging being impossible, the Japanese carried up and laid down within 800 yards of the village, rows of sandbags to form a low breastwork about two feet high. Before dawn the firing line took up a position lying down behind these parapets and remained there while the artillery shelled the village. This line was hardly near enough, and the Japanese were compelled to advance from it; this they did to within about 300 yards of the village where they endeavoured to establish another line by bringing up half-filled sandbags under fire, but the bags were heavy and the progress of the carriers necessarily slow, and here the casualties were heavy. Their persistent efforts were however successful, and the hot fire brought to bear on the village from the further position

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forced the Russians to retire, and at 2 p.m. on the 11th March the Japanese occupied Yueh-pu-tsz.

The failure of the Japanese attacks during the battle of Mukden on the Russian positions in the villages of Yang-shih-tun, Kan-kuan-tun and Sha-to-tsz on the 6th March was largely due to their inability to build up a strong firing line within decisive range of the villages owing to the impossibility of making entrenchments in the frozen ground. The attempt to make up for the inability to entrench by laying down sandbags was not so successful on this occasion.

6. *The Construction of Entrenchments to enable Reinforcements to Advance.*

This method of employing entrenchments in the attack was made use of by the Japanese during the battle of the Sha-ho; though partaking more of the nature of entrenchments used for the deliberate attack of a fortress than hasty fortifications used in the field, it was nevertheless considered by the Japanese worth the time and trouble expended and is typical of their deliberate and painstaking methods.

The occasions on which field fortification will thus be used in the attack may possibly be rare, but the necessity or the desirability for its employment may arise, and it has therefore been referred to here and an example quoted.

At the battle of the Sha-ho the 2nd Japanese Army commenced its advance on the 10th October; the Russians in their front were occupying a position south of the Shih-li-ho from the villages of Erh-tai-tsz to Wu-li-tai-tsz. Just before sunset on the 11th the enemy was driven out of both these villages and retired on to the line of the Shih-li-ho, where he held a very strong position. At 10 p.m. on the 11th the 3rd Division, 2nd Army, set to work to entrench themselves 300 yards north of Hsiao-chien-kou, a village just north of Wu-li-tai-tsz, and in order to enable them to reinforce under fire the troops holding this line of entrenchments they connected it to the village by a zigzag approach. The enemy opened fire while this was going on, but in the dark most of his shells went overhead and the Japanese did not cease their work. In addition, in order to get reinforcements up from one village to another, short trenches with a frontage of about two yards were dug at every 25 paces.

These preparations no doubt largely contributed to the successful advance next day when the Russians were driven from their position on the Shih-li-ho.

7. *The Construction of Entrenchments on a Captured Position in order to hold it, to resist Counter-Attack, and to form a "Point d'Appui" for a Further Advance.*

This is the most usual and also the best known method of employing entrenchments in the attack, and has for a long time been recognised as a suitable opportunity for aggressive fortification. If any reference at all is made in the text-books to the use of entrenchments in the attack,

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it relates as a rule solely to their utility as a means of securing ground already won. This applies to the text-books of foreign countries equally with our own.

There were naturally many examples of it during the Russo-Japanese War. At the action of Yushiu-lin on the 31st July the Japanese, after capturing the Makurayama heights by a surprise in the morning and hanging on all day under fire from the Russian batteries and infantry on the Shi-san ridge and heights in the neighbourhood spent the night in entrenching on the crest of Makurayama and constructing gunpits for their artillery, in readiness for all eventualities in the morning.

The position on the Makurayama Hill has been compared to that on Spion Kop.

At the battle of Liao-yang the 48th Regiment, forming part of the Japanese 6th Division, was told off on the 30th August to attack the village of Ku-chia-tzu, situated at the foot of the Shou-shan-pu Hill on the east side. Finding their progress checked by the fire from the village of Chiu-chia-pu-tzu on their left flank, the 1st Battalion was sent against this village and captured it at about 5 p.m. The village was at once put in a state of defence and, thanks to this precaution, a determined counter-attack by the Russians that night with the object of retaking the village, was repulsed.

At the battle of the Sha-ho the 6th Division, 2nd Japanese Army, was engaged on the 14th October in attacking the enemy in the vicinity of the Sha-ho-pu Railway station; the Russians were occupying the village of Ling-sheng-pu north of this place; at about 4 p.m. the Russians were driven out of Ling-sheng-pu after desperate fighting. At once the Japanese troops set to work to prepare the place for defence, a work which they carried out in spite of the concentrated fire of six Russian batteries. It was as well they did so, for at about 11 p.m. that night three battalions of Russian infantry made a vigorous counter-attack and nearly surrounded the village; as it was, however, they were driven back with heavy loss. At 6 a.m. next morning several Russian battalions again made a most desperate counter-attack against this village, getting quite close up under cover of a hamlet which lies adjacent to it, but were, however, again repulsed after a severe bayonet fight. A third counter-attack on the village was made about 1 p.m. but with no better success, the Russians losing heavily in all these attacks.

The Russians continued their counter-attacks on this devoted village again next day, the 16th October; no less than six times did they attempt that day to retake the village, the first being made at 6.30 a.m. and the last about 7.30 p.m., but all were repulsed. These desperate attempts to retake Ling-sheng-pu indicated the value the Russians put upon its possession.

To take another example from this battle. On the 11th October the 15th Brigade, 1st Japanese Army, was ordered to take the hill of Tera-yama, or Temple Hill as it has been called from the Chinese Temple on its summit. The attack began at 3.30 p.m.; the Russians had good cover and fought desperately. The temple itself was taken about 5.10 p.m., but it was much later before the Russians were all driven off

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the hill; the Japanese at once set to work to dig and during the night made excellent trenches all round the temple buildings.

They were thus enabled to repulse three separate counter-attacks on the hill made by the Russians after dark; the large number of cartridge clips seen lying about next morning showed the severe nature of the fighting. The position so prepared served as a *point d'appui* for the further advance on the enemy's positions on the hills to the north.

In the Boer War the benefits to be derived from at once entrenching any position seized was frequently demonstrated, though the reluctance of the Boers to counter-attack did not emphasise this necessity to such an extent as would have been the case had our enemy been of a more enterprising nature.

In the operations on the Upper Tugela, as soon as the South African Light Horse had driven the Boers from Bastion Hill on January 20th they at once proceeded to entrench this important point on the flank of the Boer position. The possession of this hill enabled the hill to its right, known as Sugar Loaf Hill, also to be taken, and eventually the whole southern crest line in front of the Boer right. Here the troops entrenched and remained until their withdrawal after the failure of the Spion Kop enterprise. Had it been decided to press the attack on the right of the Boer line of entrenchments, these positions would have afforded a valuable *point d'appui* from which to advance.

Again after the capture of Vaal Krantz on the afternoon of the 5th February by the 4th Brigade steps were taken to prepare cover; had this very necessary precaution been neglected the troops would have suffered very heavily next day from the concentrated fire of the Boer guns. The Boer counter-attack on this hill on the afternoon of the 6th was beaten off.

The cover so prepared was so much improved on the evening of the 6th that the casualties from the Boer artillery fire next day were insignificant. That the possession of this important point was not eventually made use of for pushing the advance on Ladysmith in no way detracts from the value of the lesson as to the advantages of entrenching under such circumstances.

In the action of Houtnek on the 30th April to the 1st May, the troops, on getting possession of the first plateau of Toba Mountain, should have at once thrown up cover in order to maintain themselves on the position won; had they done so, the Boer counter-attack led by Colonel Maximoff, or more serious attacks had they been made, might have been beaten off more easily. The Boers still held the crest of Toba Mountain until midday on the 1st May, and had they been more enterprising would doubtless, during the night of the 30th April, have endeavoured to drive the British from the positions they had gained during the day.

At Colenso the Queen's would no doubt have been able to maintain themselves in that village by putting it in a state of defence had not the situation in other parts of the battlefield necessitated their withdrawal.

An example of the desirability of mounted troops being instructed in the necessity of making cover to enable them to hold on to positions they may have seized pending the arrival of the infantry was afforded during

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French's great flank march on Kimberley. His sudden appearance at Ronddavel Drift over the Modder River on the afternoon of February 13th so surprised the small force of Boers there, that his cavalry were able to seize this drift and the line of kopjes beyond, covering both it and Klip Drift two miles upstream. The putting of these kopjes in a state of defence was of the greatest importance, for had the Boer force under Commandant Froneman, despatched by Cronje to attack the British force at the Drifts, carried out its orders and made a prompt attack that night, the outposts holding the kopjes would have had all they could do to hold their own and prevent the bivouacs being rushed and the drifts over the Modder lost. This outpost line was not taken over by the infantry until the morning of the 15th February.

Again on February 17th, when French by his forced march from Kimberley succeeded in heading off Cronje at Vendutie's Drift, his position was distinctly precarious and his object might not after all have been attained had not the cavalrymen been able to turn to full advantage the cover afforded by the kopjes they had seized, and so defeated the counter-attack of the Boers from the Kodoesrand with the object of recapturing Kameelfontein.

This was also forcibly demonstrated in a small way during the Zand River operations. On the 10th May a detachment from Porter's Cavalry Brigade pushed on and seized the Vredes Verdrag kopje, an important hill in rear of the Boers' right flank. Shortly afterwards a party of the Waterburg Commando crept up under cover of a donga and made a counter-attack on the kopje. The detachment was driven in confusion down the hill and lost fourteen killed, thirty-six wounded, and two officers and twenty-seven men taken prisoners.

In the operations round Johannesberg, 28th to 29th May, 1900, it fell to the mounted troops again to seize an important position, viz., the ridges east of the Klip Spruit, which were taken by Alderson's and Hutton's Mounted Infantry. This ridge was like a wedge driven into the middle of the Boer position and protected the bridge at Van Wyk's Rust. The troops hung on to this position in spite of being exposed to flanking fire from the Boer guns. Here is a case where entrenching by mounted troops was most essential.

These examples demonstrate in the most practical way the necessity of at once setting to work to entrench any position taken during the attack, also that to wait for nightfall on the plea that it is impossible to entrench under fire may very possibly lead to the loss of a position, won perhaps at the cost of many lives and heavy fighting. Had the Japanese waited till dark before entrenching and putting the village of Ling-sheng-pu in a state of defence on account of their being under the concentrated fire of several Russian batteries, they would not have been ready to repulse the counter-attack by the Russians late that evening.

8. *The Construction of Cover to enable Troops to cling to the Ground they have reached, but from which they are unable to Advance.*

This description of entrenching in the attack is to a certain extent included in the one just described, but, whereas that had reference to

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some definite position either a village, height or line of entrenchments, this refers to points where attacking troops are checked before they reach the objective.

In many cases to retire from such a point would be disastrous, not only to particular troops concerned, but perhaps to other troops engaged in the enterprise in different parts of the battlefield. Troops so situated are particularly susceptible to counter-attack; of this the enemy will be well aware, and, unless some entrenching is done and cover provided to assist them in maintaining their ground, they are likely to be driven back with heavy loss.

At the battle of Teh-li-sz on the 15th June the 3rd Division, 2nd Japanese Army, was told off to attack the left and left centre of the Russian position, while the 5th Division and a portion of the 4th were to turn the Russian right. The right of the 3rd Division, from the nature of the ground, could not receive artillery support, and could not advance against the heavy fire from the Russian trenches; the troops of the Division however clung desperately to the ground they had reached, and drove back the frequent counter-attacks made by the Russians.

They hung on until the success of the 4th and 5th Divisions on the Russian right enabled them to again advance and occupy the position.

This Division's obstinate refusal to be driven from the point it had reached was of the utmost importance to the result of the battle, for it seems that it was the Russian General's intention to counter-attack by throwing his left against the Japanese right, and there can be little doubt that the failure of the Russians to drive back the Japanese in this part of the field, even though the latter were unable to advance, entirely upset the Russian plans.

At the battle of Mukden the general advance of the Japanese armies commenced on the 1st March, 1905. The Guards Division forming part of the 1st Japanese Army was pushed on the night of the 2nd March to attack the Russian positions at Tang-chia-tun, in order to assist the advance of the Yalu Army operating on the right of the 1st Army. The Russian position was, however, too formidable and too well defended to be taken by a frontal attack, and after suffering severely the Guards stopped the attack. They hung on however to the ground they had won, and, though they were unable to advance, they maintained their precarious position until the night of the 7th March when the Russians generally gave way, and the pursuit began. Throughout this period the position of the Guards Brigade was most critical, during the 4th March there was no communication between their front line, clinging to the foot of the Russian position, and the reserves on the south side of the valley. They occupied bits of dead ground among the low hills, throwing out firing lines sheltered behind low sandbag parapets.

So close were these to the Russian trenches that the men behind them could not move hand or foot during the daytime.

The situation was only slightly relieved on the 5th March by a distribution of the 12th Division. It was their skill in making cover, and making the best use of that already existing, backed by splendid courage, which enabled these troops, in spite of the dangers and difficulties described, to

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hold their ground, and their stubborn maintenance of their position not only assisted the Yalu Army to advance but no doubt prevented the Russians from reinforcing their right, which was being threatened by the Japanese 3rd Army.

In the attack on the Boer laager at Paardeberg on the 18th February, 1900, the attacking troops, in spite of every effort, were checked in their attempts to reach the laager both on the east and west; in both cases the attack got to within about 500 or 600 yards of the Boer trenches, but, owing to the deadly fire, could not advance further in spite of the gallantry of the troops. Here was an opportunity for the employment of this method of entrenching. It was not long before dark that the last desperate attempts by the Mounted Infantry, Essex and Welsh Regiments on the east, and the Cornwalls on the west, were brought to a standstill. Directly darkness came on the troops might have at once entrenched themselves at the furthest points they had been able to reach. They would thus have been enabled to cling to the ground they had won, and have established themselves within a short distance ready for a fresh advance on the morrow. It is true that the troops had had a most exhausting day's fighting, following on even more exhausting marches without proper sleep or food, but it was the lack of training and ignorance as to the value of entrenching in such circumstances rather than lack of spirit that led to the omission of this necessary operation. It was doubtless Lord Kitchener's intention that the troops should entrench where they were, ready to renew the attack that night or early next morning, but his subordinate commanders, unused to the notion of at once making good with the spade the slightest advantage gained and knowing the exhaustion of their troops, with a few exceptions, ordered the withdrawal of their men after dark.

The action of the Gloucesters who had been ordered to drive the Boers under De Wet from the hill known as Kitchener's kopje showed an appreciation of the value of entrenching under such circumstances. They had been unable to advance beyond the foot of the hill by dusk, but promptly entrenched, and, though no fresh advance was made from this line of entrenchments that night, or till the afternoon of the next day, yet they were able by their rifle fire to keep down to a considerable extent the Boer fire from the hill during the day, and, when at last they were allowed to advance late in the afternoon, they quickly succeeded in establishing themselves on one end of the hill. Here they again promptly entrenched, and had they not, in consonance with other plans, been ordered to retire, they would no doubt have secured the hill, the possession of which was of considerable importance that night or early next morning.

Had the Gloucesters pressed on from their entrenched position on the night of the 18th, or early morning of the 19th, they would have surprised De Wet while making desperate efforts to drag a Krupp gun and a pom-pom on to the top of the kopje and prepare emplacements for them, and might possibly have succeeded in capturing the guns as well as the hill.

After the severe fighting which attended the taking of the crest of the line of kopjes known as the Wynne Hills on February 22nd during

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Buller's advance on Ladysmith, the Boers, though driven from the crest, had only retired to their real line of defence further back on the hills. The British troops holding the crest could not advance and spent the night in making such cover as they could to enable them to cling to the edge of the hills: here they, their position thus strengthened, were enabled to hang on all next day (23rd) and were relieved by fresh troops that evening.

9. *The Construction of Slight Cover by the Firing Line while advancing to the Attack.*

Here again this use of entrenching may be considered as included to a certain extent in the above, but the method now described refers only to cover, made as a rule under fire, and while the firing line is temporarily checked, or halted pending the completion of movements by other troops working in conjunction with it. It is in this use of entrenching that the absolute necessity of the soldier, carrying an entrenching tool, and being thoroughly instructed in its use, is shown; the circumstances which necessitate this kind of cover preclude the possibility of tools being brought up either in carts or on pack animals, and the same applies to their being sent up by hand.

The necessity of the provision of some such tool will be referred to more fully below; in the meantime some examples of the many occasions during the South African and Russo-Japanese Wars when the use of this method of entrenching was found invaluable, or would undoubtedly have proved invaluable had it been employed, may be quoted.

At the battle of Liao-yang the attack by the 18th Regiment on the south-east extremity of "Rocky Hill" on the early morning of the 31st August has already been referred to; one battalion of the Regiment was detailed as a reserve, there was no cover for it, and when day broke the men were lying in the open; they however protected themselves by cover thrown up under the enemy's fire.

In the same battle in the attack by the 48th Regiment on the village of Ku-chia-tzu the advance of the 3rd Battalion, forming the firing line, was checked at about 3.30 p.m. when about 500 yards from the village on account of the heavy fire from the front and from the village of Chiu-chia-pu-tzu on the left flank. The firing line thereupon halted and threw up cover, while another battalion of the regiment advanced against and captured the village on the flank. This cover was improved when darkness fell, and the line thus reached was held until the early morning of the 1st September in spite of several counter-attacks by the Russians.

During the battle of the Sha-ho the Japanese 3rd Division was ordered to attack the Russian line along the Shih-li-ho, from the village of that name to that of Yin-te-niu-lu. The attack began in the early morning of the 11th October. A portion of the troops of the Division was detailed to take the village of Nan-kuan-tsz, a hamlet about 200 yards south of Yin-te-niu-lu. The Russian troops in this hamlet were however strongly reinforced and the Japanese advance was checked; the ground was perfectly open and exposed to artillery fire, but the Japanese managed to

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throw up slight shelter at the point they had reached, and were thus able to drive back a determined counter-attack by the Russians made at 12.30 p.m., supported by the concentrated fire of their artillery. After the repulse of this counter-attack there was a lull, during which this slight cover was improved into trenches, and ammunition brought up for the next advance which took place shortly after and the hamlet was taken.

On the 11th October the 3rd Brigade, 2nd Division, Japanese Army, advanced to the attack of the Russian position on the San-joshi-san Hill. About 1.30 p.m. after a desperate encounter the Japanese occupied the low hills west of San-joshi-san, they could not push on to that position owing to the stubborn resistance offered by the Russians there, so they at once grubbed up shelter with their small entrenching tools and hung on to the ground they had won.

In the same battle on the 14th October the 6th Division, 2nd Japanese Army, was attacking the village of Lin-sheng-pu, the subsequent defence of which against the numerous counter-attacks by the Russians has been referred to above; at 12 noon on that date the troops of this Division reached about 600 yards from the village which was strongly held; here the Japanese advance was checked and cover made by them in the open under fire. A little later in the day assisted by an attack by a portion of the reserve on the Russian flank, the Japanese advance was resumed and the Russians driven out of the village at about 4 p.m.

During the battle of Mukden the frozen condition of the ground made the construction of this kind of cover almost impossible; the heavy entrenching tools of the engineering equipment were powerless to make any impression, and the light tool carried by the men was of course quite ineffective. In spite of this however the Japanese made every attempt to create cover of one sort or another, using various expedients.

The most common of these was sandbags which were distributed to the men, and, before the attack was launched, some earth was placed in them and they were carried forward so that a few inches of cover might be obtained. Sometimes earth was thus carried forward on pieces of *tente d'abri*. In other cases the men filled their haversacks with frozen lumps of earth and placed them in front of them where they lay, and again on other occasions their packs were taken off and used as cover and were found to be of great use as a protection against shrapnel.

In the attack by the 8th Division, 2nd Army, on the village Yueh-pu-tsz on the 1st March, a breastwork of sandbags had been constructed 800 yards from the village at night; in order to advance from this line it was necessary to make some attempt to make cover between it and the village. Partially filled sandbags were accordingly carried forward by short rushes up to a point 300 yards from the village, but even when only partly filled the bags were heavy, the rushes were consequently very slow and only for short distances of 20 or 30 yards at a time, and the casualties amongst the carriers were heavy. The forward move was however made about noon and the village itself taken about 2 p.m.

Again in the attack on the village of Sha-to-tsz by the 5th Division on the 8th March, the first line of the attacking troops reached a point some 400 yards from the Russian entrenchments. Here they remained and

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endeavoured to make what cover they could by scraping up the ground and using the expedients referred to above. The fact that most of the killed in the attack were shot while lying down showed the value of even slight cover.

In the Boer War the actual use of entrenching of this description was rarely made, for one reason that the troops were not provided with an entrenching implement carried on the men and for another that they had not been trained in the making of cover under such circumstances. There were however many occasions when its employment would have been of the greatest value. In the action of Elandslaagte on the 4th October the Devons, after commencing their attack on the Boer position on the hill, had to remain lying down under fire waiting for the flank attack to develop, taking advantage of what cover the ant-heaps afforded; the ant-heaps were as it happened plentiful, and being 18 inches or more in height and hard as sun-baked bricks gave good cover to those who could get behind them; but the circumstances afforded an instance of an occasion where cover hastily made with an entrenching implement would have been invaluable.

Again at the Modder River on the 28th November, 1899, when the Guards and 9th Brigades were surprised by the fire suddenly opened upon them at 1,200 yards' range by the Boers concealed in the bed of the river, there was absolutely no cover. The men could do nothing but throw themselves down on their faces behind scattered ant-heaps or the low leafless scrub and attempt to reply to the fire proceeding from the dark belt of green marking the river bed. By making short rushes the 2nd Coldstreams and the Grenadiers managed to advance to within about 1,100 yards of the Boer trenches, but they could advance no further.

They held on to their ground, but in the absence of any vestige of cover they could not open fire with effect, and remained prostrate on their faces in the burning sun. Had the men been able to employ themselves in making cover the advantage would have been twofold—in the first place they would have been able after a slight delay to open fire with some confidence, and, secondly, the moral strain involved by being obliged to lie thus idle and motionless would have been eased by the effort to make cover without attracting the keen-eyed enemy's unpleasant attentions.

The situation of the Highland Brigade, after the failure of the night attack on the Magersfontein trenches, was similar but worse, for the shattered remnants of the Brigade lay all along the front of the Boer trenches, in many cases at point blank range; it cannot be denied that to have made cover at such close proximity to the enemy's rifles was well nigh impossible, but men trained to use a suitable implement in the prone position might have managed it, and the effort would, as in the previous case, have served to relieve the strain on the mind.

They were not all at such close range and those who might have been able to protect themselves would have been in a better position to help their comrades by keeping up an accurate fire on the Boer trenches. The Seaforths on the right would also have had a better chance of maintaining their position had they been able to improve the slight natural

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cover afforded by the ridge which they had reached immediately after the disaster to the Brigade at dawn.

One more example. On the afternoon of the 21st February, 1900, the troops advancing to the relief of Ladysmith began crossing the Tugela by the pontoon bridge west of Hlangwane; the 10th Brigade crossed first and occupied the kopjes covering the bridge without much opposition, but when the leading battalion advanced on to the plain beyond they came under a very heavy rifle fire from the Boers in the bed of the Onderbroek Spruit. The advance was eventually brought to a standstill, and the men had to remain lying in the open for the rest of the afternoon, exposed to heavy rifle fire at a comparatively short range. This was a situation when ordinary entrenching tools could not possibly have been pushed forward and probably could not have been used if they had, but with an entrenching tool each man could have made cover for himself where he lay, and the firing line could thus have gradually dug itself in: the cover so made could have been improved during the night, and the Boers in the Spruit would have possibly retired next morning, or in any case their fire which proved so galling to the troops engaged in seizing and holding the Wynne Hills on the 22nd would have been largely neutralised.

10. *The Construction of Entrenchments by Troops whose Assault has been repulsed, from whence to make a Fresh Effort or resist a Counter-Attack.*

Troops unless well disciplined and well led are particularly liable under these circumstances to become demoralised, and, if they be allowed to retire unchecked too far, the retirement is only too apt to degenerate in a rout, more particularly should the enemy seize the opportunity to make a counter-attack. The desirability of halting as soon as the troops have withdrawn out of close range and hastily throwing up cover behind which the men can rally is obvious. The cover thus improvised will provide a point to limit the retirement, will assist the troops to recover their morale, and enable them to resist the almost inevitable counter-attack. The cover can be gradually improved and will prove valuable as a *point d'appui* from which a fresh effort, probably after reinforcements have been pushed up, can be made to assault the enemy's position.

At the battle of the Sha-ho use of this method of entrenching was made by the Russians. On the 11th October they began their advance to turn the Japanese right, and attacked the Umezawa Brigade in an advanced position north of the Tsu-men-tzu Ling Pass. The Russians were unable to reach their objective that day, but on the early morning of the 12th renewed the attack and assaulted the position with the bayonet. The assault was repulsed after desperate fighting, and about 2 p.m. the Russians gradually, a few at a time, began to retire, taking advantage of whatever cover there was. At about 800 yards from the position they rallied and threw up shelter trenches where they stayed. At 2 a.m. on the 13th they again made an attack which was also repulsed; they maintained their entrenched position throughout the 13th, but retired together with other portions of the Russian forces on the night of the 13th.

At the battle of the Sha-ho the troops of the Japanese 5th Division on

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the morning of the 5th March attacked the Russians holding the railway embankment in front of the villages of Sha-to-tsz and Mi-chia-pu; after severe hand-to-hand fighting the Japanese got possession of the embankment, the Russians retiring into Mi-chia-pu and Sha-to-tsz. The Japanese hung on to the embankment until midnight on the 7th March when the large reinforcements received by the Russians in the villages indicated the probability of a vigorous counter-attack. The Japanese in their present position were not well situated to meet this, so retired to a position on some sandhills further west, where they made entrenchments. The threatened counter-attack did not come off and the Japanese again advanced on the evening of the 8th.

At Colenso it would seem that this use of entrenchments might have been made with the best results. After the general failure, owing to various causes, of the attack of the Brigades on the Boer position, it would have been quite possible, instead of retiring the troops altogether to the camp at Frere, to have withdrawn them out of rifle range and there constructed a line of entrenchments. Behind these the troops, who were in no way demoralised by their ill success, could have been re-formed, their fire would have protected the deserted guns of Colonel Long's batteries, and enabled them to have been brought in after dark, while, had it been considered desirable to renew the attack with the knowledge now acquired of the Boer position, the troops would have been much better situated for carrying it into execution. The spirit of the troops themselves and the reluctance of the Boers to leave their positions would have made the task of making such a line of entrenchments an easy one.

11. *The Construction of Entrenchments in the Local Counter-Attack.*

The main counter-attack by an army, holding a defensive position, assuming the offensive does not differ materially from the attack, and the various methods of entrenching, above described, apply equally to it. Even in local counter-attacks, however, occasions may occur when it may be advisable to entrench. At the battle of the Sha-ho the Japanese 4th Division was attacking the village of Ling-sheng-pu on the 14th October, the left wing of the Division being thrown back. At 11 a.m. and again at 3 p.m. about four Russian battalions supported by artillery made a counter-attack on the Japanese left wing. Being checked in their advance at about 600 yards from the Japanese, they set to work to entrench; as, however, this work was attempted not in the prone position, the target offered to the Japanese riflemen was a good one, and the Russians in consequence suffered so severely that they broke and fled. Had they been able to maintain the position gained the taking of the important post of Ling-sheng-pu by the Japanese would have been greatly delayed.

THE JAPANESE ENTRENCHING TOOL AND HOW CARRIED.

Admitting the fact of the successful employment by the Japanese of entrenching in the attack under the various circumstances cited above, for it is undeniable that it is to them we must look for the most useful and

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valuable lessons, it at once becomes of interest to know with what kind of entrenching tools they were provided, tools put to such good use throughout the campaign. Each Japanese company (roughly 200 men) was provided with 67 light spades, 17 light picks, 5 hand axes and 5 folding saws; these tools were carried by the men themselves (the N.C.O.'s carrying the saws). The front and rear ranks carried the tools on alternate days. In this way wherever the company might go and under whatever circumstances it might find itself, there were sure to be a certain number of entrenching tools on the spot. The spades were carried vertically, handles downwards, on the left side of the valise, the picks and axes were carried horizontally across the top of the great coat; they were fastened by string, etc., to the blue holdall when the valise was discarded. In addition to these tools each battalion (4 companies) was followed by two ponies carrying tools in light kajawahs, twenty shovels and eight picks on each pony, or forty shovels and sixteen picks per battalion. These latter were no doubt very useful for night work, but circumstances must very often occur when to bring up tools on ponies, or even by hand, to the neighbourhood of troops engaged in the attack is absolutely impossible.

The Use by the Japanese of Entrenching Tools.

The Japanese infantry soldier was taught to look on his entrenching tools as second only in importance to his rifle; whenever he halted in the attack he endeavoured, so to speak, to go to earth and traces of their spade work could be seen whenever infantry halted in an attack. They won their way forward with their rifles, but got their grip of what they had won by means of the spade. There was no attempt to make the necessity for entrenching an excuse for not pressing on to the attack, each bit of cover thrown up, each trench made, was regarded only as a stepping stone, a footing from which to make another stride in the advance on the enemy's position. Packs were often discarded in the attack, entrenching tools never.

As to the type of work usually made that depended entirely on circumstances; when time and opportunity offered trenches of strong profile were made, usually 4 feet deep and 3 feet wide, with about 1 foot cover in front; a trench of this section was made by the Japanese infantry in three-quarters of an hour working in three reliefs, but often the only shelter was that which could be scraped up by men lying on the ground, while, as has been related, when the frozen ground forbade digging, haversacks and valises were made use of.

The Entrenching Tools of the Japanese Artillery.

The Japanese batteries carried 6 spades, 3 picks, 2 axes (1 large and 1 small), 1 saw, and 1 billhook per sub-division, strapped underneath and to the sides of limbers and wagons and inside the store wagon. The good use made of these tools is evident from the examples already quoted.

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The Japanese engineers were frequently employed in assisting the gunners in preparing cover for the guns, approaches, etc., but the gunners were independent of the engineers, and many were the occasions when they had to rely entirely on themselves for the making of the necessary cover. The type of cover for the detachments usually consisted of pits 4 feet to 5 feet long, 3 feet wide and from 2 to 5 feet deep, a similar pit being usually made beside the ammunition wagons. As has been pointed out above the Japanese almost invariably threw up artificial cover for their artillery before coming into action; even though such cover had to be made during a fight and in daylight, the results were well worth the trouble expended.

The Japanese themselves, as a result of their experience gained in the war, came to the conclusion that it was necessary to provide still further facilities for entrenching, and accordingly in future every Japanese soldier is to be provided, when mobilised, with an entrenching tool. The number of entrenching tools per battalion carried by the pack ponies is to be increased while an attempt is to be made to render the light entrenching spade carried by the men more efficient.

THE RUSSIAN ENTRENCHING TOOLS AND HOW CARRIED.

The Russians have long been noted for their extensive use of entrenchments, but these have usually been employed in the defence. It has been alleged against them that in their case the rifle has been subordinated to the spade, and that they are wont to commit the error of making their tactical plans subservient to their defensive preparations. During the campaign the Russian soldier carried the Linneman entrenching tool, which is very similar to the light spade carried by the Japanese, it was worn on the right side in a case handle downwards. The proportion of tools carried was 80 Linneman spades and 20 light axes per company. The artillery was likewise provided with entrenching tools, the number of which, owing to the experience gained, was increased during the course of the war.

THE BRITISH ENTRENCHING TOOLS AND HOW CARRIED.

There is no need to describe here in detail our own system of carrying entrenching tools in the field, but, as regards India, it might be noted that hitherto the tools of a battalion of infantry, which consisted of 8 felling axes, 40 pickaxes, 40 shovels, 40 billhooks, 2 crowbars and 2 spokeshaves have been carried on six obligatory mules, which immediately followed the battalion. By a recent Indian Army Order the proportion of pickaxes and shovels have been increased to 48 and 160 respectively, while the number of mules has been increased to eight. This is distinctly a move in the right direction as each company thus will have its own mule carrying 6 picks and 20 shovels, and will, to that extent, be independent and self-contained.

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THE NECESSITY OF AN ENTRENCHING IMPLEMENT CARRIED ON THE SOLDIER.

But though a step in the right direction, this cannot be considered, judging from the lessons of these recent wars, as providing an adequate supply of tools, or a satisfactory solution of the question of their availability at all times and under all conditions. In accordance with the principle hitherto followed in the British service of making the soldier carry on his person as little as possible, a principle partly due no doubt to the fact that he has often to fight in tropical climates where to carry a heavy kit is too exhausting, and partly to the necessity of not imposing too heavy a burden on the men of a voluntary army, the carrying of an entrenching tool by the soldier himself has not been insisted on. It is possible too that until recently the necessity of his doing so was not sufficiently clearly proved. But whatever sound reasons there may be for carrying as much of the British soldier's kit for him as possible, recent wars have indubitably proved the necessity of his carrying an entrenching tool. What would have happened to the Japanese soldier time and again had his ability to make cover depended on the possibility of pack animals being pushed up into the firing line or even to the supports, the occasions were rare indeed, except at night, when this would have been possible, while even at night entrenching had often to be done under a hot fire which would have made very precarious a supply of tools which depended on the ability to bring up pack animals. No better example of the danger of the infantry soldier being so dependent could be found than that furnished by the plight of the troops forming Colonel Carleton's column on reaching the Tchrengula Hill on its way to Nicholson's Nek for the stampede of the mules left them without the means of making any cover other than that obtainable from sangars of piled-up stones; these offered ideal targets to the Boer riflemen while affording only insufficient protection to their occupants.

Foreign countries have for some time recognised the necessity of the infantry soldier carrying an entrenching tool; as has been said, both the Russian and Japanese infantry were provided with them before the war. Such tools are now carried by the French and German infantry, while only recently experiments have been carried out in the United States Army with a new pack for the infantry soldier, with which is worn, attached to the belt, a short pickaxe, a small broad axe and a shovel for entrenching.

That well-known authority, General de Négrier, has said*:—"In attack the entrenching implement has become a necessity to every infantry soldier. He should be practised in making entrenchments when lying down, gaining cover gradually in this way until he is completely hidden." While His Excellency the Commander-in-Chief in India, in his speech at the conclusion of the recent Meerut Rifle Meeting, said "The late Japanese War has shown us how impossible it is for troops to advance over exposed ground, within range of the enemy's guns and

* "Some Lessons from the Russo-Japanese War." *Revue des Deux Mondes*—January, 1906.

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rifles, without the cover of darkness or hasty entrenchments. Hence night operations to gain advanced positions and light entrenchments thrown up thereon to enable them to be held in daylight, should form an important part of our training. Every man will, I hope, soon be supplied with a handy entrenching tool, and his life may often depend on the proficiency with which he handles it."

Backed by such weighty opinion the necessity for the provision of an entrenching tool to be carried on the infantry soldier may be considered as proved. It then only remains to decide—(*a*) On the best kind of tool, (*b*) The method of carrying it, and (*c*) The number to be allowed per company.

THE REQUIREMENTS OF AN ENTRENCHING IMPLEMENT.

As regards (*a*)—The requirements of such a tool seem to be as follows:—

(i.) Portability.
(ii.) Strength combined with lightness.
(iii.) Suitability for the particular work required of it
(iv.) Accessibility.

To fulfil the *first* requirement the tool must not be unwieldy in length or breadth; it must in no way interfere with the soldier's movements either when marching or doubling, or with various positions adopted when firing.

To ensure the *second* it must be made of the best hardened steel, and weigh not over 3 lbs.

For the *third* it must be capable of being readily used by a man lying down, and must be such as to produce the best results in different kinds of soil.

As to the *fourth*, since the tool will often have to be used while the soldier is lying down exposed to fire, it must be within easy reach and capable of being detached and replaced with one hand while in the lying position.

The entrenching tool carried by the Japanese troops in the late war was in the form of a light shovel with light pickaxes in the proportion of about one pick to four shovels.

Although the Japanese achieved such good results with these tools they were not altogether satisfied with them, and are experimenting with a view to improve the shovel. The Russian soldiers were provided with a very similar tool, shovels and pickaxes in the same proportion. The proportion of tools to men in the former army was about two to three, and in the latter one to four.

In the German Army 400 small shovels and 40 small picks are carried by the men of an infantry battalion, which works out to about a proportion of three tools to four men.

The drawback to the above distribution of tools is that, though the shovel is undoubtedly the most useful all-round tool for digging, there are many occasions when a man requires a pick, *e.g.*, to tackle a particularly hard bit of ground, to remove the earth round, or lever up a

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stone, etc. Now the circumstances under which these tools are utilised are often such as to preclude an interchange of tools between the men, consequently the man with a shovel must make shift to get on with his shovel, and the same the man with a pick. The intention nowadays in selecting a soldier's kit is to make him independent and, so to speak, self-contained; it is therefore obvious that, for such an important item as the entrenching tool is likely to prove in future, he should be independent of his fellows. The ordinary shovel too is from its nature not well adapted for use while lying down.

Long experience has proved that the pickaxe and shovel are the two most useful implements for digging, and having regard to the above remarks, it is obvious that it is a combination of these two in one useful tool that is required.

This desideratum has been recognised before and was endeavoured to be met by the introduction of the Wallace patent entrenching tool; the drawback to this implement was that, when using the pick or grubber, the blade of the shovel was apt to cut the arm, and it was also not wholly suitable for use by men lying down.

Description of an Implement Suggested.

The tool described below would, it is believed, fulfil all the above requirements, it being borne in mind that the intention is that such a tool is not intended to do away with the necessity for the ordinary entrenching tools accompanying troops, but for use under circumstances when these latter are not available, and could not be used if they were.

The accompanying rough sketch (not reproduced.—Ed., *R.E.J.*) will explain the nature of the implement, and gives its dimensions (Shovel, length, 7″; width, 6″. Pick, length, 7″. Handle, length, 9″; width, 2″ at bulge.—Ed., *R.E.J.*). The particular points in its favour are:—

(i.) It combines the two descriptions of tool essential for entrenching.

(ii.) It is particularly adapted for use by men lying down, and can, if necessary, be worked with one hand.

(iii.) It can be worn attached to the belt without in any way interfering with the wearer's movements.

(iv.) It can easily be detached for use by the wearer when lying down and equally easily refastened.

The swelling of the handle midway between the two ends should afford an easy grip and reduce the liability to blister and cramp; the length of this portion is such as to admit of its being grasped with two hands, one above the other, whichever end of implement is being used. What usually forms the "treads" of the spade, not being required in an implement of this sort, are slightly sloped so as to obviate the possibility of the user's hands being cut or bruised by the edges when using the spade portion. For comfort in use the handle is covered with leather.

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MANNER OF CARRYING THE IMPLEMENT.

As regards (*b*)—The intention is that the tool should be carried suspended from the waist belt, on the opposite side to the bayonet, in the manner here described:—The point of the pick fits into a pocket of stout sole leather, connected with a leather loop, to slip on the belt, by a stout leather strap about an inch and a-half wide lying along the back of the handle of the implement, the weight of the implement being thus borne by the loop.

To the loop is also sewn a leather flap of such a size that, when folded over, it will form a cover, for the spade portion of the implement. A small strap is sewn through the lower part of the flap to the loop; this strap is passed round the handle of the implement and fastened to a stud sewn on to the folded-over portion of the flap, and in this way secures both the flap and implement. Thus by one movement the flap can be opened and the retaining strap released.

The hollow of the shovel and the curve of the pick are made to face in opposite directions, in order that the former may sit more comfortably under the wearer's arm and the latter turn outwards from his leg.

DISTRIBUTION.

Now with regard to (*c*)—There should be no doubt whatever as to the necessity of every infantryman carrying a tool. There were many occasions during the Russo-Japanese and Boer Wars when the situation was such that, unless a man was himself carrying a tool, he must and did go without; such occasions are instanced in Nos. 8 and 9 of the various uses of entrenchments in the attack quoted above. This fact has been recognised by the Japanese authorities and arrangements are being made accordingly. It should, however, be clearly understood that the arrangements for carrying tools, as recently laid down, should not be interfered with in consequence or the number of tools per battalion decreased.

THE IMPLEMENT NOT MEANT TO SUPERSEDE THE ORDINARY TOOL.

The soldier should be thoroughly practised in the use of his entrenching implement under the various circumstances in which it would be utilised on service; he should be taught to regard it as second only to his rifle in importance, and that as Lord Kitchener said, "his life may often depend on the proficiency with which he handles it." At the same time it should be impressed upon him that, to quote Lord Kitchener again, "such artificial cover (as is intended to be made with the implement) should be entirely distinct from entrenchments made to defend a position when time is available and more efficient tools can be used," and that the implement should be reserved for such.

THE ISSUE OF SANDBAGS FOR USE WHEN THE GROUND IS ROCKY OR FROZEN.

One more point seems to require notice and that is the great difficulty experienced during the battle of Mukden by the Japanese in making use

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of entrenchments during the attack, owing to the frozen state of the ground. Allusion has already been made to the various expedients resorted to by them to overcome this serious difficulty, the most important and successful of which was the issue to the infantry and artillery of sandbags. The use of sandbags, however, will not be limited to occasions when the frozen condition of the ground prohibits the digging of entrenchments; many will be the occasions when the rocky nature of the soil will be as prohibitive of entrenching as though it were frozen, in any case as far as deep entrenching is concerned. Here the sandbag will prove equally indispensable.

The troops sent up to occupy Spion Kop were plentifully supplied with entrenching tools, and engineers to guide and assist, but on the mountain top the solid rock was covered by but a shallow layer of earth, and the trenches could not be deepened. Here sandbags would have been invaluable for there was ample earth on the surface to fill them, and they would have provided the necessary depth of cover, which could not be obtained by digging down; they would also have been most useful for improving the natural cover provided by the rocks. Sandbags, however, formed no portion of the entrenching equipment of regiments, and, though it is said they were to have been issued, the fact remains that they were not. Under General Warren's orders several thousand sandbags were sent to be distributed among the troops that were being sent up to reinforce those on the summit, but the circumstances, viz., broad daylight and a withering fire concentrated on the hill were such as to prevent effective use being made of them. The nature of the country in which our forces in India may have one day to operate is likely to provide both frozen and rocky soils, it seems therefore a reasonable suggestion that when circumstances are likely to necessitate their use, sandbags should be issued to infantry and artillery, every man of the former being supplied with one, if not two; these could easily be carried rolled up, while a certain number should always form part of the equipment of the pack mules carrying the entrenching tools.

There are not wanting those who maintain that digging is now being rather overdone, that the main object of the attacker, viz., to drive the enemy from his position with as much loss to him as possible is apt to be lost sight of, and that it will be difficult to get troops to advance once they have got under good cover. Such arguments show either that the proper use of entrenchments in the attack has not been thoroughly understood, or that the training or *morale* of the troops is deficient. It must always be remembered that in the attack, equally as in the defence, entrenchments and field fortification must be regarded as but the means to an end.

As the Alpine climber, when cutting footholds in the ice with his axe, or supporting himself with his alpenstock, is bent only on reaching the summit of the mountain, using such aids merely to enable him to cling to the height he has reached and to provide a footing from which to climb higher, so must the use of entrenching be regarded by the attacker, *i.e.*, solely as a means of enabling him to reach his goal—the enemy's position.

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EXPLOSION OF GELIGNITE IN PEMBROKESHIRE.

The following extracts, from a Report by H.M. Inspector of Explosives, on the circumstances attending an explosion which occurred during the operation of thawing gelignite in connection with G.W.R. extension in Pembrokeshire, 26th February, 1906, will be read with interest:—

Circumstances of the Accident.—The construction of the line was being carried out by Messrs. J. I. Firbank, Ltd., and the explosion severely injured one man, and slightly injured two. The severely injured man, George, was the chargeman, and it was his duty to prepare the charges and fire shots in the holes which had been drilled in the cutting on the previous day. The cartridges used were of unusual size, being 2 in. in diameter, and weighing 1¼ lbs. each. At the season at which the accident occurred these cartridges were congealed, and it was therefore necessary that they should be rendered plastic before use. A fatal accident, which had occurred before on the same works, had been attributed to the use of a partially softened cartridge, and had probably awakened all to a lively sense of this necessity.

George therefore had risen very early on 26th February, and at 2.30 a.m. had got out the gelignite which he wanted, amounting to 30 cartridges, or about 37½ lbs. He had only two warming pans, and into each of these he placed six cartridges; the remaining 18 he placed in a bucket which he stood in another bucket containing hot water, and covered up. This procedure which was irregular, had no bearing on the subsequent explosion, as the cartridges in the bucket were not involved. At 4.45 a.m. he found that some of the cartridges were sufficiently soft. He therefore took 3 of them out—these also were not involved.

He now took 2 of the cartridges from the second warming pan and placed them in the first, to take the place of those which he had removed. He then went to the fire, and fetched a can of water which was heating there; this water he states was not so hot but that he could bear his hand in it. He returned to the warming pan containing the 5 cartridges, and set the can containing the hot water on the ground, while he emptied out the cooled water from the jacket of the warming pan. It should be noted that the ground in the cutting was very wet. He then proceeded to pour the hot water into the outer part of the warming pan, when he heard a slight hissing noise, and immediately afterwards the explosion occurred.

Effect of the Explosion.—George was knocked down, but was not rendered unconscious. He sustained a large number of punctured wounds, from which pieces of the warming pan were subsequently extracted.

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The effect on the warming pan itself was most remarkable. Of the lid no traces were found except the small pieces taken out of the wounds; the body of the pan on the other hand showed no signs of an explosion. The internal dimensions were the same as those of a new pan, and the only damage was the fusing of the upper margin for about ½ an inch. In the bottom of the pan was found a considerable quantity of residue similar to that which remains when gelignite has burned away quietly without explosion.

What Probably Occurred.—The hissing was produced by active decomposition of the gelignite due to causes mentioned later. This generated sufficient gas to blow off the top of the pan, and the top cartridge. On the lid reaching the ground the cartridge, already in an extremely sensitive condition, was detonated by the blow, and exploded, blowing the lid to pieces.

Causes of the Explosion.—If this theory is correct it only remains to ascertain the cause of the decomposition. Experience shows that raising the temperature rapidly, even assuming that the water was hotter than George stated, should not decompose the gelignite if pure. An ignition by a spark, which is unlikely as the lid of the pan was on, would have caused a bright yellow flame which would have been far more noticeable on a dark morning than the hissing sound.

Unstable Explosive.—This leaves the alternative that the explosive was unstable. A sample was obtained, and submitted to the "Heat test" which it stood well—too well indeed, for the chemist had suspicions that it might have been treated with a "masking agent" which, whilst having no action in improving stability, effectually prevents any indication by the heat test.

The gelignite was then subjected to the test employed when examining a new explosive. In the result the figures would have been sufficiently serious to have caused it to be rejected without hesitation.

A surprise visit to the factory revealed no trace of the use of "masking agent," but further tests leave no doubt that one had been used.

The conclusions therefore are as follows:—

(i.). That the explosive ignited spontaneously in the warming pan.
(ii.). That the explosion occurred outside the warming pan, but in close proximity to the lid.
(iii.). That one at least of the cartridges was made of very unstable explosive.
(iv.). That an unauthorised and illegal ingredient had been added to the explosive which had the effect of concealing its lack of stability.

Since the report was submitted the presence of mercury (part of the "masking agent") was definitely proved by the spectroscopic method in a number of samples, and the firm was convicted in the one case which was taken into court.

E. G. GODFREY-FAUSSETT.

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NOTICES OF MAGAZINES.

Engineering Record.

November 23rd, 1907.

Density of Pavements.—The density or specific gravity of the pavement as laid, is found to be a good measure of its wearing quality. In a bitulithic pavement laid in Boston, where the crushed stone was very carefully graded by sizes and so mixed as to obtain a very small percentage of voids, a specific gravity of 2·69 was attained, as compared with a specific gravity of 2·96 in the stone used for crushing. Asphalt pavements, as used in the U.S., vary in specific gravity from 1·90 to 2·25, while the constituent stone has a specific gravity of 2·60—2·70. By taking the density of other paving material such as asphalt, brick, wood, etc., a fair measure of their wearing qualities may be estimated, but of course other considerations, such as the surface obtained, etc., are of high importance in considering the wear and cost.

Road Tarring and Dust Prevention.—Both U.S. experience and the results of the British road tarring trials are quoted. A variety of binding agents have been used, *e.g.* heavy oil, coal gas tar, water gas tar, oil gas tar, and various patent compounds. Assuming the binding powers to be equal the results appear to depend greatly upon the actual penetration effected. Before laying on the tar, etc., the surface usually needs to be cleaned so as to remove fine dust and ground-up stone.

Both sand mixed with stone screenings, and peastone have been used with fair success, but generally speaking the latter seems the better. Calcium chloride has also been tried successfully as a dust preventive in some places, "keeping new macadam moist and holding it in dry weather." There are some notes on tar-spreading machines, which are usually fitted with rotary spreaders. The descriptions are hardly sufficient to permit of comparison between different types.

C. E. Vickers.

Memorial de Ingenieros.

July, 1907.

A Token of Gratitude.—The pay of the staff for Engineer services, viz. of the foremen of works, artificers, clerks, and draughtsmen, has recently been very considerably increased owing to the efforts of the senior officers of the Corps, who highly appreciate the good work and loyal service rendered by them. In token of their gratitude, the staff for

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Engineer services has presented, to the head of the Engineer section of the Ministry of War and to his colleagues, a very handsome bronze plate bearing a design typifying the various duties of the Corps such as fortification, ballooning, telegraphy, surveying, railways, etc., the whole designed and executed by members of the staff. This was accompanied by an album containing the signatures of the donors, and has been deposited in the museum of the Corps, where it will form an interesting memorial of the good feeling which exists between all ranks.

STUDY OF THE WORK DONE BY THE CABLE OF THE TIBIDABO FUNICULAR RAILWAY UP TO 31ST DECEMBER, 1906.—By Lieut.-Colonel D. Mariano Rubio.—Tibidabo is a mountain near Barcelona, and its summit, a popular resort of the inhabitants of that city, is reached by means of a funicular railway. The track is single and straight, except in the centre where there is a siding 100 mètres long to enable cars to pass one another. The curves at the entrance to, and exit from, this siding have a radius of 250 m. The line may be divided into three sections, the lowest 60 m. long has a gradient of 17 p.c., the central 300 m. long a gradient of 23 p.c., and the highest 690 m. long, one of 25·7 p.c. The rails are of the Vignoles type. There are two carriages, each weighing 6,400 kgs. and having accommodation for 80 passengers. They are connected by a steel cable formed of 96 wires round a hemp core. This wire at the summit of the line passes round a drum actuated by a motor. The diameter of the cable is 28·8 m.m., metallic section 3·03 sq. c.m., weight 2·75 kgs. per mètre, breaking weight 44·5 tons. It runs on guide rollers, and, in the event of its breaking, the cars are held by brakes which automatically clip the rails the moment the strain is taken off the cable. From its opening in 1901 to the end of 1906 the line has carried 634,000 passengers on the upward journey and 567,000 downwards. The author calculates the strain on the cable in the various sections of the track, and arrives at the total work performed during the period under consideration.

THE SIMPLON TUNNEL.—By Major D. Francisco Ricart.—The author gives an interesting account of the tunnel and of the work connected with its construction.

HERO'S FOUNTAIN.—By Major D. Alfredo Amigó.—Although the principle of this fountain was discovered by Hero 120 years before the Christian era it has never been more than a scientific toy. The author considers this to be due to the difficulty and expense of constructing pressure chambers of sufficient capacity, but now that armoured concrete has been introduced, these difficulties can be readily overcome. If this is so the author considers that, with a given head, Hero's fountain will prove more efficient than any form of turbine for raising water from the reservoir furnishing the power. The writer shows that the capacity of the upper pressure chamber should be equal to that of the lower, divided by the effective pressure in atmospheres in the latter.

MILITARY REVIEW contains a note on the organization of a British Balloon Company and its *matériel*.

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August, 1907.

THE SIMPLON TUNNEL (*concluded*).—This number contains an interesting account of the difficulties which were met with in the construction of the tunnel, and of the means which were adopted to overcome them. They were mostly due to the presence of water in the limestone rock. In the summer of 1901 work had to be suspended, as the tunnel was flooded to a depth of 2 feet and a large part of the plant was washed away. Before work could be resumed a drainage tunnel had to be constructed at a level lower than that of the main gallery, a difficult proceeding as the miners had to work in water up to their knees and were soaked by the springs which constantly burst out from the walls. The quantity of water dealt with on this occasion amounted to about 200 gals. per second.

Further on, a zone of shifting and decomposed rock, about 132 feet in thickness, was met with and caused great trouble. The rate of progress dropped to about 10 inches a day. A lining formed of 12″ × 12″ timbers was found to be of insufficient strength and had to be replaced by iron, whilst the permanent masonry lining was given a thickness of 6′ 7″ on the invert, 6′ at the footings, and 5′ 4″ at the crown of the arch, a whole year being occupied in its construction.

At the end of April, 1904, a hot spring was met with at a point 10,270 mètres distant from the Brigue end of the tunnel. Its temperature was about 120° F. and it discharged some 1,800 gals. a minute at a pressure of from 3 to 4 atmospheres. An attempt was made, unsuccessfully, to block it up, and eventually an iron shield was fixed in position from which the water was led away in pipes, the pressure being sufficient to force it up to the highest point of the tunnel, whence it flowed down to the Brigue entrance.

Hot springs caused even greater difficulties in the boring of the main gallery on the Italian side, and refrigerating appliances had to be installed in order to reduce the temperature to one at which work could be carried on.

INSTRUCTIONAL TOURS CARRIED OUT BY THE STUDENTS OF THE ENGINEER ACADEMY DURING THE YEAR 1906–1907.—The students at the Engineer Academy at Guadalajara are taken, during the fourth and fifth years of their course, on instructional tours, similar to those carried out from the S.M.E., though the amount provided for the purpose in the estimates is somewhat inadequate. During last year the 4th year students went on an 18 days' tour to Madrid, Zaragoza, Monzón, Monistrol, Barcelona and Tarragona, and visited the chief military establishments and engineering works at those places, such as the military hospital at Carabanchel, the engineer laboratory at Madrid, the military railway which is under construction from Madrid to San Martín de Valdeiglesias, the Aragón canal, the Monistrol rack railway, the harbour works at Barcelona with its floating dock, etc., etc.

The 5th year students visited Madrid, Ferrol, and Segovia between the 1st and 16th May. Ten days were spent at Ferrol in visiting the dockyard and the various men-of-war, S.M. test-room and barracks, and lectures

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were given, by the professors of the Naval school, on different types of ordnance, machinery, etc. The fortifications of the port were also visited, and lectures were given by artillery officers on the various coast defence guns and mountings, and by the Commanding Engineer on the fortifications. At Segovia the students were attached to the Regiment of Siege Artillery and witnessed practice from the guns, howitzers and mortars which belong to it.

AN AERO-MARITIME VOYAGE.—By Capt. D. Alfredo Kindelán.—At 7 p.m. on the 24th July, 1907, Capt. Kindelán ascended from Valencia in the balloon "Maria Teresa," the wind at the time blowing towards the land. A storm came on and he was driven out to sea in the direction of the Balearic Islands, and a further change of wind carried the balloon in a northerly direction towards Barcelona. At about 6 a.m. on the 25th the heat of the sun caused the balloon to rise to an elevation of about 12,500 feet at which it remained until about 9 a.m. when, owing to the sky becoming covered with clouds, the temperature fell very considerably, and caused it to drop very suddenly to a height of only about 100 feet above the sea. In spite of throwing out everything possible the balloon continued to sink and by 12.30 p.m. the car was in the water. The wind again changed and blew the balloon in the direction of the island of Iviza. The unfortunate aeronaut remained hanging on to the balloon until 7.30 p.m., when as the wind commenced to again carry him away from land, he decided to try to swim towards the shore, which was about 10 miles distant. At 8 p.m. he was sighted by the s.s. *West Point*, and was picked up and landed at Garrucha on the 27th July. Capt. Kindelán gives a very clear and modest account of his adventures which had awakened the greatest interest in Spain.

'M.'

NATURE.

December, 1907.

A TOTAL SOLAR ECLIPSE will take place on 3rd January, 1908. The line of totality passes from a point in the Pacific, east longitude 155° and north latitude 12°, in a curved path through Polynesia, terminating in Mexico. The only two portions of land from which totality can be seen are two small Pacific islands, viz., Hull Island, in the Phœnix group, and Flint Island, to the north of Tahiti. Hull Island is surrounded by a coral reef which makes landing very difficult—except by boats on the N.W. side—and there is no anchorage. Flint Island is 2½ miles long and half a mile wide; is also surrounded by a coral reef; landing is very bad even for surf boats. The Americans have, however, determined, in spite of all these difficulties, to occupy Flint Island. The navy department is providing a war vessel to transport the Lick Observatory Expedition, under the direction of Prof. W. Cambell, from Tahiti to Flint Island

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and back. Mr. W. H. Croker, of San Francisco, who has defrayed the expenses of five previous expeditions, has again offered to finance this one. At Flint Island the duration of totality will be 4 minutes, and the sun will have an altitude of 74°. The epoch of minimum sun spots will be at time of eclipse in 1912, while that of the greatest solar activity was in 1905, so that the eclipse of 1908, occurring in an intermediate year, renders it important even from this view alone.

THE FUTURE WATER SUPPLY OF LONDON (*p.* 132).—The Metropolitan Water Board is the largest and most important water authority in the United Kingdom, being responsible for the supply to one-sixth of our population. The distribution of rainfall, on which water supply depends, is, speaking broadly, the inverse of the distribution of the population. Taking the part of England and Wales south of the Trent, it may be said that most people live in the Thames Valley, while most rain falls in Wales. The works at present in existence or authorised will supply London until 1917, and to provide the additional works, required at that date, it will be necessary to approach Parliament in 1910.

The total amount of water which the Board can abstract from the Thames under existing conditions is 228,500,000 gallons a day, and even this amount cannot be obtained until additional storage reservoirs have been constructed. The maximum supply to be relied on, from sources other than the Thames, is 120,000,000 gallons per day, the whole total thus available being 340,500,000 gallons per day. If London increases in population at the present rate, this amount will suffice till about 1940, but not longer. The chief engineer believes that, by constructing very large reservoirs, 450,000,000 gallons per day could be taken economically from the Thames. Under these circumstances the Water Board "desire to urge upon Parliament the necessity for regulating the appropriation of water-supplying areas, so that the needs of the Metropolis, as well as of other populous places, may receive due consideration."

ASCENT OF THE TRISUL IN GARHWAL (p. 135).—Dr. Longstaff, Major Bruce, with Mr. A. L. Mumm, the secretary of the Alpine Club, went to India with a desire to attempt the ascent of Mount Everest (29,002 feet in height) from the Thibetan side, but for political reasons this was found to be impossible. It was decided then to go to Garhwal and from that locality to attempt Trisul (about 23,000 feet). The summit was reached on 13th June, but the cold was so bitter that it was only possible to remain there for a quarter of an hour.

[From the foot of this mountain, with a glass, snowstorms and drift snow are constantly seen on the three peaks. The Garhwalese say that they are caused by demons who live on the top of the mountains, and that no human being could possibly escape with his life, should he have had the temerity to undertake the ascent of this devil-haunted sanctuary.—WM. E. W.]

TRAIN RESISTANCE (p. 156).—Mr. C. Wilson has found that the resistance of the air with a train of bogie coaches, running at 60 miles an hour,

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amounts to about one half the total tractive effort required to draw the train. A large reduction can, however, be made in the front and rear air-resistance by shaping the ends, and that by this means a saving can be effected of 10 per cent. of the total tractive effort with a long passenger train, and 30 per cent. with a single coach.

LORD KELVIN (p. 175).—At the ripe age of eighty-three, Lord Kelvin has passed away. To three generations of scientific men, his work, his presence, his mathematical genius, and his enthusiastic faith in first principles, have been an inspiration and a perpetual stimulus. The notice of his life in *Nature*, by Prof. Silvanus P. Thompson, is well worth reading.

BALLOON OBSERVATIONS (p. 187).—Twenty-five balloons, with registering instruments, were sent up in England and Scotland during the week July 22—29. Fourteen of the registering instruments have been found. The heights ranged up to more than 12½ miles, the average being about 7½ miles. The records showed that above 7½ miles the temperature remained almost unaltered with change of height.

THE SALMON (p. 173).—Mr. Calder Wood has collected into a book a great deal of most valuable information bearing upon the life and habits of the salmon. The first two years of the salmon's life is normally spent in the parr stage. It then assumes the silvery livery of the smolt when, on reaching the sea, it eludes for a time the ken of man, until it reappears as a grilse a year after it left the river as a smolt.

W. E. WARRAND.

RIVISTA DI ARTIGLIERIA E GENIO.

October, 1907.

CHANGES OF MILITARY OPINION AS REGARDS THE VALUE OF FORTRESSES.—Under this title H. Frobenius in the Supplement No. 103 of the *Internationale Revue*, traces in an interesting article the changes of Prussian Military Opinion from the days of Frederick the Great, on the subject of the value and importance of permanent fortifications.

Frederick valued fortresses highly as aids to war, but, after his death, the greater number of commandants of fortified places, as well as the Prussian army, were dominated by the genius of Napoleon, and considered that it was better for a country not to risk the safety of her troops in the defence of a fortress. After 1815 Prussians had not the heart to defend their frontier with permanent works.

Later on the great advance in siege guns, the effects of curved fire on masked works, and finally the siege of Sebastopol all combined to injure the returning confidence in fortresses (1856–57), and the siege operations in the American war were of insufficient importance to influence prevalent opinions. The vast improvement in artillery jeopardised the very existence of fortresses by bringing their power of resistance into question.

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The War of 1870–71 dispelled these illusions, and the power of the Prussian siege artillery fell far below expectation. The renewal and construction of numerous fortresses was the result of these experiences, even though sieges were treated as "accessory matters" in the work of the Great General Staff.

Opinion next veered towards "improvised" fortifications owing to the resistance at Plevna, and at the same time the development of railways diminished the value of fortresses as supply bases.

Moltke strengthened this view by enunciating that, "when taking the initiative, railways can defend a country better than fortresses." Now, however, it is realised that railways and fortresses are of equal importance.

In 1880 new champions of improvised works arose, viz. Sherff and Sheibert, and they further argued the possibility of strong forces making their way through the intervals in a chain of forts. This idea was long held in Germany, but was looked upon as absurd at Port Arthur.

The armoured constructions of Major Schumann again raised the prestige of fortresses, as the explosive shells and mephitic gases were of little use against the cement and steel armoured works, and could not render the indestructible redoubts uninhabitable. These peace demonstrations received thorough confirmation at the Siege of Port Arthur, where the Japanese artillery neither annihilated the Russian force nor sensibly diminished the strength of the works. It also failed either to drive out the garrison, or to facilitate the final attack.

Thanks to this siege the fortress has recovered its former great reputation, and artillery has been shown to be nothing more than an indispensable auxiliary to the infantry.

MAGAZINES FOR EXPLOSIVES.—Experiments have lately been made in Germany in the construction of magazines with gravel cement to contain explosives. In order to diminish the danger of fragments, in the event of an explosion, these explosives are generally stored in shelters of light construction. But shelters so constructed are equally badly adapted for protecting their contents against external agents (heat, moisture, lightning, etc.) as they are for guarding them from theft. They were however adopted as it was argued that they were less dangerous in the event of an explosion than gravel cement magazines.

To test this assertion two magazines of cement were constructed at Cummersdorf. The vault was 50 c.m. in thickness at the key and was supported on walls 1·25 m. thick. The fronts of the magazines consisted of thick walls 50 c.m. formed with gravel cement. In each of the magazines one of the front walls had an opening which was kept secured by a gate of strong steel plates in one case, and in the other by a simple wooden gate strengthened with thin plates. At 2 mètres distance from the gate a bank of earth was thrown up to stop the fragments.

The charge exploded for the first magazine was 1,500 k.g. of gelatine explosive, for the second 500 k.g. only.

The result of the trials was not very characteristic, but clearly showed that the danger from the fragments is not greater in a gravel cement magazine (which is in fact completely disintegrated), than from those of

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a light shelter. The gate of strong steel also gave more fragments than the light wooden one which was completely destroyed. The utility was also proved of a bank of earth in front of the gate, as it arrested the horizontal fragments and these are by far the most dangerous.

RIVISTA DEI LIBRI E DEI PERIODICI.—The "Provisional German instruction in field fortification" is a translation by Gustavo Suchet, colonello del genio: Rome, 1907. In April of this year, in this Review, was published a study entitled "The new provisional instruction in field fortification," relating to a publication which appeared lately in Germany under the title: *Feldbefestigungsvorschrift* (Enwurf).

At a very convenient time, the War Minister has allowed the whole of the valuable translation to be published of the Instruction made by Colonel Suchet, and this work will serve a useful purpose in instructing all officers in the new principles which should regulate the construction of works of field fortification.

The first part of the Instruction relates to the general principles of the employment and method of field fortification. The second part continues the rules for the execution of works and offers numerous types for adoption according to the conditions of time and place. The third part deals especially with the use of field fortification in the attack of fortresses. The fourth part relates to various technical particulars.

The German Instruction is dedicated to all branches of the army, and especially to the infantry, whose officers should be able to learn from it to apply the methods of fortification on the battlefield in all conditions of warfare.

From which we may infer that the volume will be read and consulted, with much profit and under varied circumstances, by all the officers of our army.

EDWARD T. THACKERAY.

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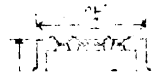

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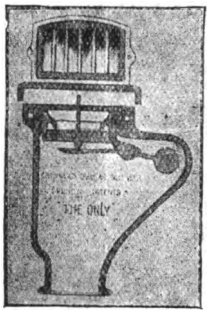

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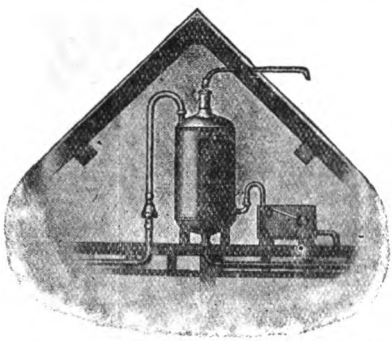

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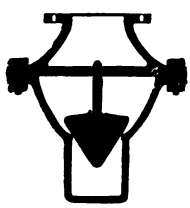

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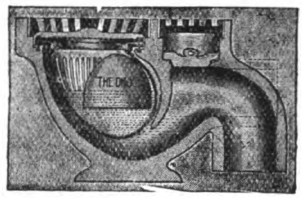

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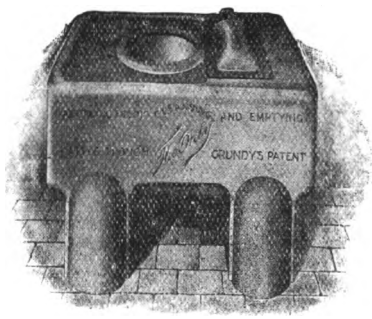

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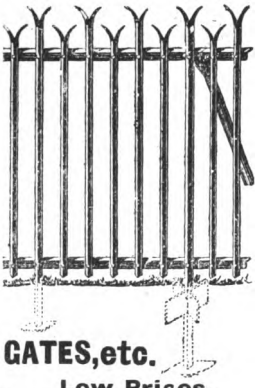

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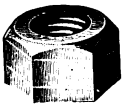

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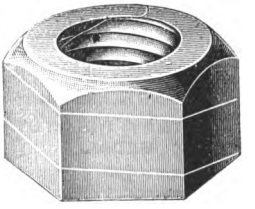

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Capt. G. N. T. Smyth-Osbourne, Devonshire Regt.
Capt. V. H. M. de la Fontaine, East Surrey Regt.
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,, B. D. L. G. Anley, D.S.O., Essex Regt.
Capt. R. S. Hamilton-Grace, Durham Light Infantry.
*Capt. H. F. Baillie, Seaforth Highlanders.
,, P. S. Allen, Gordon Highlanders.
,, J. K. Cochrane, Leinster Regt.
,, R. L. Ricketts, Indian Army.
,, W. K. Bourne, Indian Army.
,, F. W. Lumsden, R.M.A.

The following Officers received nominations:—

Capt. H. C. Bickford, 6th Dragoon Guards.
Capt. C. J. C. Grant, Coldstream Guards.
Capt. W. D. Wright, V.C., Royal West Surrey Regt.
Capt. C. H. Harington, D.S.O., Liverpool Regt.
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Capt. and Bt. Major N. J. G. Cameron, Cameron Highlanders.
Capt. G. P. Grant, D.S.O., Indian Army.

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N. H. Hutcheson	2,105	D. C. Robinson	1,879
F. D. Frost*	1,949	F. A. Bowring	1,876

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Vol. VII. No. 3. MARCH, 1908.

CONTENTS.

		Page.
1.	**A Scherzer Rolling Bridge over Canal at Weedon.** By Col. A. H. Bagnold, C.B., R.E. (*With Photos*)	125
2.	**Government Telegraph Office, Cantonments, Quetta**	129
3.	**Coast Defence.** By Major F. Molony, R.E.	131
4.	**Communication in the Field.** By Capt. R. C. Hammond, R.E.	139
5.	**The Foundation of the Royal Engineer Establishment at Chatham.—II.** By Lt.-Col. B. R. Ward, R.E.	153
6.	**Transcript:**—The Service of Aeronauts in War. (Translated from the *Eenzhenernee Zhoornal* by Major F. E. G. Skey, R.E.)	160
7.	**Review:**—*Behelfsbrücken-Vorschrift.* 1907. ('E.')	166
8.	**Notices of Magazines**	167
9.	**Correspondence:**—Earthquake at Jamaica, 2nd January, 1908. By Bt.-Col. W. R. Stewart, R.E.	173
10.	**Recent Publications of Military Interest**	175

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CONTENTS.

PAGE.

1. A SCHERZER ROLLING BRIDGE OVER CANAL AT WEEDON. By Col. A. H. Bagnold, C.B., R.E. (*With Photos*) 125

2. GOVERNMENT TELEGRAPH OFFICE, CANTONMENTS, QUETTA 129

3. COAST DEFENCE. By Major F. Molony, R.E. 131

4. COMMUNICATION IN THE FIELD. By Capt. R. C. Hammond, R.E. 139

5. THE FOUNDATION OF THE ROYAL ENGINEER ESTABLISHMENT AT CHATHAM.—II. By Lt.-Col. B. R. Ward, R.E. 153

6. TRANSCRIPT :—

   The Service of Aeronauts in War. (Translated from the *Eenzhenernee Zhoornal* by Major F. E. G. Skey, R.E.) 160

7. REVIEW :—

   Behelfsbrücken-Vorschrift. 1907. ('E.') 166

8. NOTICES OF MAGAZINES :—

   Revista de Engenheria Militar. By 'M.' 167
   Revue du Génie Militaire. By Capt. J. E. E. Craster, R.E. 168

9. CORRESPONDENCE :—

   Earthquake at Jamaica, 2nd January, 1908. By Bt.-Col. W. R. Stewart, R.E. 173

10. RECENT PUBLICATIONS OF MILITARY INTEREST 175

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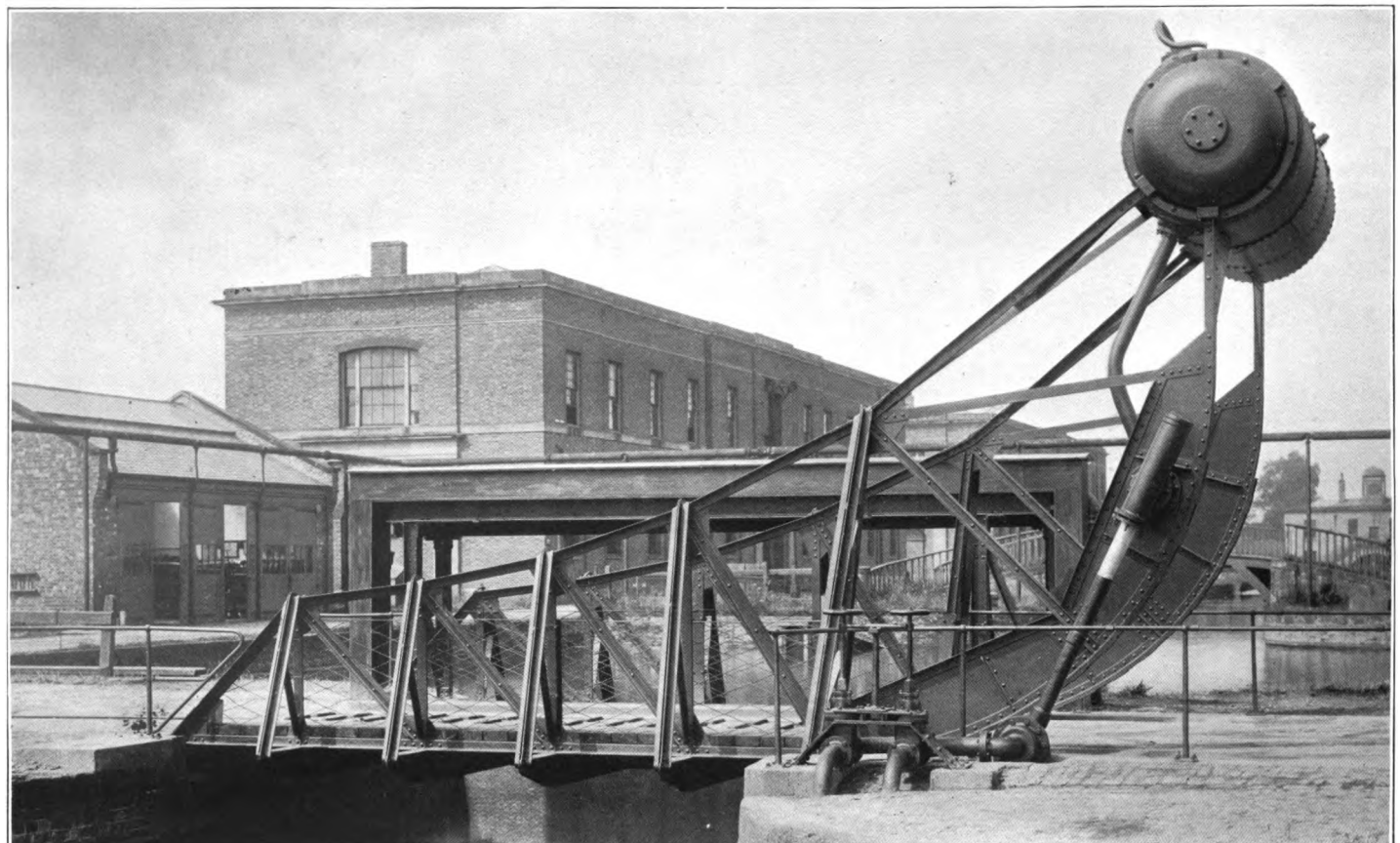

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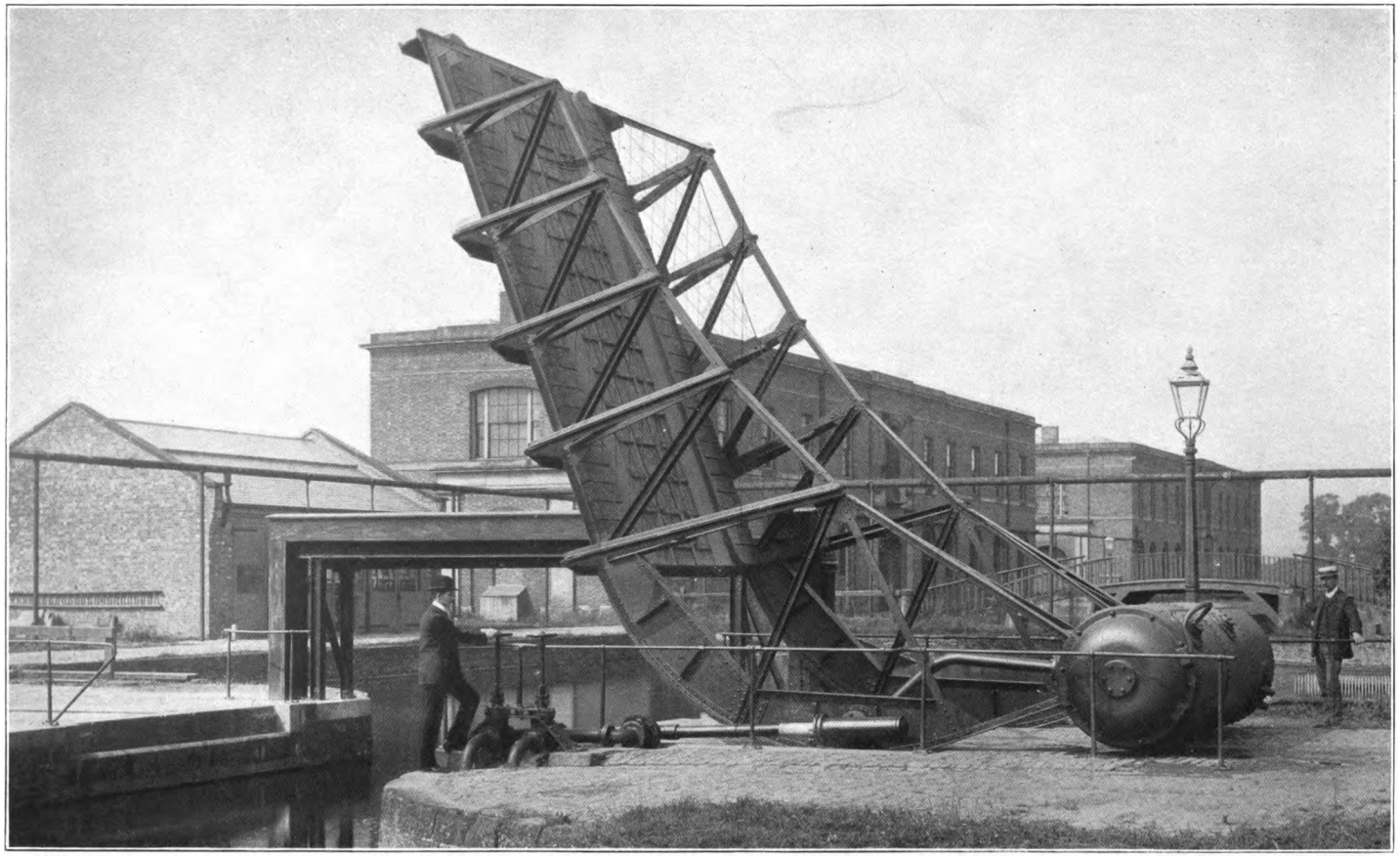

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A SCHERZER ROLLING BRIDGE OVER CANAL AT WEEDON.

By COLONEL A. H. BAGNOLD, C.B., R.E.

THE Ordnance Store Depôt at Weedon is well situated as regards means of communication. The main road between London and Birmingham, the main line of the L. & N.W. Railway, and the Grand Junction Canal, all pass close by the main gates of the Depôt. A private siding is led into the Depôt, as is also a short branch from the Canal.

This branch canal, however, practically cuts the Depôt into two portions, access between which is somewhat limited, and in providing for the increased storage accommodation—found necessary by the experience of the South African War—a new movable bridge, to take heavy van traffic and an 18-inch gauge tramway, was rightly considered an essential.

An old and troublesome roller bridge existed, but it was in a decayed and dangerous condition, and as its design necessitated steep movable ramps at either end, it was not practicable to take a tramway across it satisfactorily.

The masonry abutments were in good order, but it was desired to avoid, if possible, the necessity of putting in such additional foundations as would be required for a swing bridge.

The descriptions, published in *Engineering* in 1904–5, of the new Scherzer railway bridge over the Swale—carried out from the designs and under the directions of the late Sir Benjamin Baker, K.C.B.—indicated the system there adopted as possessing considerable advantages, and as being peculiarly adapted to the requirements at Weedon. The similarity between this system and the Moncrieff gun-carriage is very noticeable.

The bridge shown in the photographs was designed, under my direction, in the Building Works Department of the Ordnance Factories, by my then chief mechanical draughtsman, Mr. E. D. McQueen, A.M.I.C.E.

The water supply of the Depôt, though not remarkable for its purity, is cheap and plentiful, as it is pumped up by the War Department, from the little river Neen, to a reservoir in the barracks, about 90 feet above the canal level. For this reason it was decided to

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effect the counterbalancing of the bridge by the filling and emptying of a cylindrical tank, as shown in the photographs.

The bridge was constructed in the Arsenal by directly-employed labour, the only manufactured parts supplied by contract being the balance tank and the controlling valves. It was temporarily erected in the Arsenal and worked almost perfectly, the only adjustment found necessary being the addition of a certain amount of kentledge, which took the form of lead run into the cast-iron caps fastened to the ends of the balance tank.

The bridge was then taken to pieces, the main girders were cut each into two pieces, and the whole was sent to Weedon by rail. It was there erected without difficulty by the local staff, and, with one exception, has worked most satisfactorily since its completion in October, 1906.

The original design provided for the connection between the fire main and the tank, by means of a short length of 4-inch galvanized flexible steel tube. The fixed end of this tube was located very close to the position of the controlling valves, as shown in the photographs, this point having been determined as giving the most suitable approximation to the mean position of the centres of curvature of the trachoid (or prolate cycloid) described by the moving end of the flexible tube, together with the least variation in radii of curvature. Although due allowance was made in the length of the tube for flexure and for variation of radii, the tube only withstood a limited number of operations, and eventually gave way.

To overcome this difficulty, the articulated and telescopic connection—clearly shown in the photographs—was designed, made in the Arsenal, sent up to Weedon, and fixed. This connection has worked now for nearly a year without any hitch whatever.

The opening and closing of this bridge is effected without any risk or liability to accident. To open the bridge it is simply necessary to open the filling valve. As the tank fills, so the bridge rolls back, and when the tank is full the water overflows from a pipe at the top. The filling valve is then closed, but if left open the result is simply a waste of water. To close the bridge, the emptying valve is opened, and the bridge rolls gently forward into its normal position without shock.

During the late frost—which was very severe at Weedon—the valves and the articulated connection froze up once, but were easily thawed, and no damage resulted. This would not have occurred had the valves been properly covered up and treated as if they were hydrants. It would, perhaps, be an improvement to place these valves underground. One necessary precaution must, however, be taken in frosty weather, and that is, that the tank must not be filled if the toe of the bridge be frozen down to its seating, for if this be done, then, when the ice gives way, the bridge will roll back suddenly,

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and the tank may strike the ground and buckle the tension members of the girders. To prevent the possibility of such an accident, "jack-screws" are being provided to enable the toe of the bridge to be freed when necessary.

The total weight of the bridge, with tank empty, is 9 tons. The capacity of the tank is 800 gallons, and the weight of the empty tank, with caps and kentledge, is 2 tons.

The opening is effected in about 1½ minutes, and the closing in about 2 minutes. The clear span is 18 feet; the clear width between girders is 10 feet, and the clear headway beneath balance tank is 12 feet.

The bridge is designed to carry a crowd of soldiers, either with or without a two-horse railway van loaded up to 4 tons. The resultant bending moment, for purposes of calculation, was found to approximate to a single rolling load of 8 tons on two co-axial wheels. Stress diagrams were plotted for numerous positions of the bridge, and each member was carefully designed to resist the maximum load which could possibly come upon it.

The stability of the bridge and the total kentledge and tank capacity were determined by taking moments about the lines of rolling contact in various positions, thus :—

Angles of Elevation.	Total Moments in ft.-lbs.		Differences.	Differences Divided by Distances of Axis of Tank from Lines of Rolling Contact.
	Bridge Side.	Tank Side.		
Horizontal	97990	44371	53619	6100 lbs. = 2 tons + *·723 tons water
25°	134023	45486	88537	8568 ,, = 2 ,, + 1·826 ,, ,,
46°	145598	39146	106452	10645 ,, = 2 ,, + 2·753 ,, ,,
67°	139594	31597	107997	12832 ,, = 2 ,, + 3·730 ,, ,,

The normal preponderance of about *three-quarters of a ton was considered sufficient to counteract wind pressure tending to open the bridge.

The only foundations required were the two track girders, which were set in concrete slabs. These girders each consist of a pair of 10″ × 3½″ steel channels, spaced 1 inch apart, with the teeth set in between them, and bolted together. The teeth of the rack are of annealed cast steel, and are 1 inch high, 6 inches long, and 2⅜ inches wide on the top. The pitch of the teeth is 12 inches. The corresponding recesses, on the curved rolling segment of the lower members of the main girders, are formed by crosspieces, or teeth, of mild steel, 6 inches long, 6⅜ inches wide, and 1⅛ inches deep, riveted on to and across the 3″ × 3″ angles of the lower member, with side-filling pieces, 6″ × 1⅞″, riveted on to the angles between the teeth.

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This type of opening bridge is, I think, superior in every respect to a swing bridge. It is simple to construct, easy to work, requires the minimum by way of foundation, and there is little or nothing to get out of order. Where water supply is available, and when the span admits, the balance tank arrangement appears to be the most stable and, therefore, the safest possible. It should make an excellent drawbridge.

For large spans, and where water supply is either not available or is expensive, these bridges must, of course, be pulled over either by hand, hydraulic, steam, or electric power, but by a suitable disposition of the kentledge the amount of energy required need not be great.

The writer would be happy to furnish any reader with further details if required.

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GOVERNMENT TELEGRAPH OFFICE, CANTONMENTS, QUETTA.

THE new Government Telegraph Office, Quetta, constructed between November, 1903, and August, 1905, at a cost of nearly Rs. 47,000, is of the bungalow type, cruciform in plan. The roof of the buildings which contain the offices proper is at a higher level than those of the two wings, and is perpendicular to the front.

One wing contains quarters for the telegraph master and his two assistants; in the other wing are housed the telegraphists. Directly in rear are the cookhouses for the different quarters, and further back blocks of servants' quarters.

The building faces south-west, and stands diagonally across a corner where two main roads intersect.

Verandahs are given all round the building, but in rear of the wings; these are enclosed, to form small bedrooms and bathrooms to the various quarters. The office verandahs are quite open, while in front of the wings, and at either end, they are screened in by close trellis work, to give privacy to the quarters.

Additional light and ventilation are provided by ridge skylights, in addition to clerestory windows in main rooms.

Two porches in each wing help to break the long line of verandah roofing, and gables that of the main roof.

The construction adopted is as under:—

Foundations.—One foot of lime concrete, with burnt brick in lime above, to plinth level.

Plinth.—Three (3) feet high, reached by steps of Kolepore stone at intervals, those in front of the central offices extending the full width of the verandah.

Superstructure.—Sun-dried brick in mud, with mud plaster and leeping,* but 1 foot in depth at top of walls is laid in burnt brick in lime.

Archwork.—Burnt brick in mud.

Roofing.—Galvanized corrugated-iron sheeting (Naini Tal pattern), with mud and puttal† ceiling, fixed to purlins.

* A kind of clay wash.
† A kind of reed.

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Roof Trusses.—Kingpost, supporting purlins, all of wood.

Woodwork.—All scantlings of roof, and in chowkuts (door and window frames) and verandahs, of deodar.

Joinery.—(i.), Teak in office rooms; (ii.), deodar in quarters and outbuildings.

Floors.—(i.), Of rooms, burnt brick on edge, in lime, cement pointed, over 3 inches of lime concrete; (ii.), of verandahs, Kolepore stone, laid in cement, over 3 inches of lime concrete.

Ceilings.—Five-eighths (⅝) inch pine planking, fixed to tie beams in main rooms, and to rafters under verandah roofs.

Water Supply.—By pipe throughout the building.

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COAST DEFENCE.

By MAJOR F. MOLONY, R.E.

SINCE Colonel Hickson has done so much to encourage us to enunciate our views on Coast Defence, no apology is needed for definite proposals on this subject. Many of our best officers probably feel themselves debarred from writing, owing to their having had access to confidential mobilization documents. The opinions which follow are in no way officially inspired.

My first proposal is that our present "Coast Defence" sections be renamed "Harbour Defence" sections. The present name is misleading.

Colonel Hickson having proposed that fixed guns should be provided for the defence of certain landing beaches, "Forts" has raised the objection that these will need guarding by infantry. For this and other reasons, the whole question of the distribution of our defensive forces is involved, and, as Capt. Walker concludes, "The first step in these matters is the evolution of a well-balanced scheme of defence."

The Volunteers and Yeomanry are to be made more efficient under the title of Territorial Army, but how is it proposed to use them to resist invasion and raids?

INFLUENCE OF RAILWAY CONSIDERATIONS ON DEFENSIVE STRATEGY.

Against an invasion threatening from Dunkirk, Queen Elizabeth concentrated at Tilbury, the lowest point where the Thames could conveniently be crossed. This allowed of her army attacking within four days any enemy who had landed between Portsmouth and Harwich. Our railway system has rendered such a concentration as she made at Tilbury unnecessary and undesirable.

From the fact that the managers of our great lines have been made lieut.-colonels in the Railway Volunteer Staff Corps, I gather that the accepted plan is as follows:—When an invader lands we propose to forward troops by rail to concentrate about two days' march inland of him (so as to be able to detrain without hindrance from his mounted troops). We then hope to crush him before he can be reinforced. The neglect of our true coast defences during the last

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50 years justifies the assumption that there is no intention of siting troops close to the coast, even if invasion be threatened. For the sake of clearness, let us call this the orthodox plan.

Now if the troops are échelonned over a reasonable area to start with, the factor limiting the working speed of the above plan will not be the entraining, but either the detraining facilities or the carrying capacity of the lines near the detraining points. Suppose there are two such, as would usually be the case, and that trains can follow each other every eight minutes and carry half a battalion each. Then the infantry of 10 divisions would be arriving at the detraining points for 16 hours. If the other arms be railed also, the time is immensely increased. Thus a delay of eight hours in entraining some of the troops need make no difference to their time of detraining; and hence, for such a railway concentration, the question where the bulk of the troops start from is not of importance, so long as some are ready to get away promptly, and take the detraining points into use.

If the crushing of an invader be the primary object of the territorial army, gaining time for completing the defences of our arsenals should surely be the secondary object, for it is notorious that even our best fortresses have large gaps in their defensive circuits. I have shown that for railway transport reasons the attainment of the primary object is scarcely affected by the placing of the troops, but the case is far otherwise with regard to the secondary object. If we can prevent a landing near our capital or arsenals, we may delay an attack upon them for several days, time which should be invaluable if good plans are ready for the completing of their defences.

PROPOSED GENERAL DISTRIBUTION.

Assuming only the 14 divisions of the territorial army available, I should propose, in a war with a Southern Power (which we will call Case I.), to allot 11 divisions to the defence of London, one to Devonshire, and two to Ireland; or in a war with an Eastern Power (Case II.), 11 divisions to London, one to the Humber, one to Newcastle, and one to the Forth, using the mounted brigades to watch such coast lines as the divisions do not guard. This disposition would not mean that an enemy landing in Norfolk or Dorset would be only opposed by the mounted brigades. If there were reason to believe that the invader had put his whole expeditionary force ashore, the 12 or 14 divisions might be moved against him, just as readily as if they had not at first been told off for the protection of vulnerable points.

The 11 divisions for the defence of London could, in Case I., guard the coast from Portsmouth to Harwich, or in Case II., from Rye to Yarmouth, but it will be found that they can only advantageously put one-third of their infantry at the railway junctions behind the coast.

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The infantry of a division whose brigades are at Eastbourne, Lewes, and Brighton can be concentrated by rail at either Eastbourne or Brighton quicker than if the whole division be at Lewes; because the far brigade will begin arriving at Lewes before the whole Lewes brigade can be got away. Similarly it will be found that 11 brigades placed at railway junctions between Portsmouth and Harwich can start the railways working to their fullest capacity, and no useful purpose is served by having more troops waiting at the junctions.

To ease the strain on our railways we should, of course, provide as much of our infantry as possible with road conveyance. With motors, bicycles, and buses we might be able to mount another third of them, which we will call the mounted infantry. As our own coast near London generally consists of long stretches of beach, interspersed with stretches of shore rendered unsuitable for landing by cliffs, rocks, or shoals, I should propose to allot one or more of these mounted infantry brigades to each stretch of beach.

Now the point is what we ought to do with the remaining third of the infantry.

I have long been convinced that they ought to be entrenched within rifle shot of the beach, for I reckon that this would give about 360 men per mile of fair landing beach in Case I. and 420 in Case II. By lessening the number where there are difficulties from shoals and rocks, we could get up to 1,000 men per mile on the Eastbourne, Brighton, or other good beaches. None of these troops on the south coast would be more than five miles from a railway, nor on the east coast more than eight. Hence, with good telegraphic and signal communication, they could be withdrawn in plenty of time to take their place in a general concentration. Behind these troops are the mounted infantry and railway reserves, by means of which we could, within four hours of issuing orders, raise the force holding any 10-mile stretch of beach up to 3,000 infantry per mile. In the light of South African experience, these numbers seem ample. The above is calculated on the assumption that no animals accompany the infantry, so that they may be able to detrain anywhere, and that at critical times, such as high water during darkness or fog, every reserve brigade keeps a train ready to start, and others nearly so.

And it must be remembered that 14 divisions, full as regards infantry, is a moderate estimate of what would be available for the defence of the British Isles. It assumes that all the Regulars and Militia are out of the country, and that none have come forward for the defence of their fatherland except those on whom the State has a lien.

Personally I think it most probable that sufficient trained men would come forward to take up the defence of the whole south coast to the Lizard, as Colonel Hickson suggests, but I should not

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propose to do much work west of the Needles till these had been organized.

Artillery.

So far we have dealt with the infantry only; the guns are a more complex problem.

I should propose to distribute such field artillery as would be available on much the same principles as the infantry, entrenching the heavy artillery on the coast, and of course putting horse artillery with the mounted infantry. But the field artillery with the railway reserves must follow and not precede them, as it takes so long to detrain, and platforms are essential to it.

To replace these early in the fight, we need badly railway guns as advocated by Sir Percy Girouard and several other writers, and practically used in several wars. Surely "Forts'" remark that "as a matter of fact at most places where the line runs near the shore the deep water is some distance out" does not apply to Kent and Sussex?

But there can be no doubt that, for these railway guns, a special system of indirect laying is necessitated by the fact that the railways rarely get a clear view of the sea.

The guns must also be able to fire broadside on without overturning the trucks. Hence special trucks, of the low type used for transporting boilers, are essential. Here is a case where experiments should certainly be made in peace time, and patterns of trucks and instruments sealed, and drawings and contracts held ready, so that a number could be ordered directly money is available. I should propose to post these railway guns at the minor junctions not suitable for brigades of infantry, and at certain points, such as Hythe, where the conditions are favourable.

ORGANIZATION.

This amended system of defence will undoubtedly mean a lot of planning and organizing. I think the railway reserves would be best worked by a chief in London, and the coast troops by sections.

Each section commander must be in telegraphic communication with all his troops, and must remember that his most important function is to advise his chief in London, especially when to stop forwarding reserves.

His next most important duty will be to see that troops arriving by rail get orders, and he must put third the locating his road reserves, as they will be numerically small compared to the railway reserves.

Sufficient senior officers must arrive on the coast before nightfall to allow of the force opposing the invader being then roughly organized. Till then everyone should act under the section commander.

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INFORMATION.

Of course, we agree with Capt. Walker that everything possible should be done to gain early information of the probable locality of a hostile landing. But his proposals, so far as I can follow them, seem to rely too much on getting this information early. Briefly, he proposes to use this information to *man* the threatened coast, and I would use it to partially *reinforce* it.

ADVANTAGES.

The advantages claimed for the above-described scheme of true coast defence over the generally accepted scheme of a concentration two marches inland, briefly, are :—

1. That it may result in the invader meeting with a bloody repulse on the coast.

2. That, by rendering a landing at the convenient beaches impossible, it would probably double the length of his march on London, and give us time to fortify the capital.

3. That it puts the advantages of entrenching on our side. The coast troops will, of course, prepare trenches for the reserves as well as for themselves.

4. Minor raids on the defended coast would be hopeless. Even heavy attacks would only have a chance if pushed at a pace which usually involves mistakes being made, and which would give little time for the naval guns to act.

5. The enemy can only make feint attacks by incurring heavy loss. We shall be better informed of what is going on upon the coast than if we follow the orthodox scheme. A concentration two marches inland might be preliminary to a blow in the air.

6. It will prevent many of our richest coast towns paying a ransom to hostile cruisers to escape bombardment.

7. Even if a landing be forced, the invader would find great difficulty in getting his guns into action ashore, and would meet with most opposition at that critical time when the control of his operations must be partly naval and partly military.

8. If he got his whole force ashore, he should still be confined within a very small area, probably affording him no good defensive positions.

9. His mounted troops and cyclists should be stopped from getting inland before the defenders have time to withdraw all cattle and transport, and most of the provisions, from the neighbourhood. As regards the first opposition to the invader's mounted troops, I hold to the principle of defending every hedge and ditch. Only thus can we prevent our big railway concentration from being hindered by broken bridges.

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10. If the invader lands near London, the amended system involves less reliance on railways than the orthodox system, and consequently would be less interfered with by the blowing up of a bridge by a spy.

11. The amended scheme secures us great liberty of action. Putting some troops on the coast does not *necessarily* mean reinforcing them there. In certain cases, as at Dungeness (the only point where a landing can be openly forced), it may be best to instruct the coast troops to retire before an invader, driving the cattle before them. On the east coast there are places where the best stand can be made a few miles back from the shore. And we have proposed nothing to render the orthodox scheme any more difficult of execution.

12. It is well to adopt from the first the policy which public opinion is likely to compel us to adopt in the end.

DISADVANTAGES.

The disadvantages of putting troops on the coast seem to me to be three.

1. The invader may use his naval guns on our troops. But his ammunition is not likely to be suitable, and any considerable expenditure will weaken his fleet, to do which is one of our primary objects.

It is not proposed that our firing line shall always be entrenched near high-water line. In some places, as Pevensey, it might be a mile back, and in any case a shelter trench is an unusual target for naval gunners.

2. The units of our divisions would be more likely to get mixed than by the orthodox scheme. This objection would be largely met by sending a very senior officer to the coast to re-allot units to divisions after the first day's fighting.

If it be evident that the invader cannot be crushed or even hemmed in, I believe our soundest policy would be to fall back to the neighbourhood of London. This retirement would give plenty of time for a re-sorting of units.

3. The amended scheme may not allow of so much being done to complete the training of the territorial army in combined manœuvres as the orthodox scheme. But it must be remembered that every fine morning, after the sea has been reported clear, the reserves can be safely marched away some miles for training, as our artillery arrangements can then hardly fail to greatly delay a landing.

I should not propose to put troops on the coast till an invasion is actually threatened. The entrenchments there can be begun by civilian labour if the plans be ready.

It must be allowed that the balance of advantages is decidedly in favour of the amended scheme over what I have called the orthodox scheme. The question is, what proportion of the troops should be

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entrenched near the coast, and what coasts they should hold? I hope to see my solution of these questions criticized.

I should propose to apply the above principles to the divisions defending the provincial arsenals. The Forth Division to hold the coast from Tayport to Dunbar; the Newcastle Division from Newbiggan to Seaham; the Plymouth Division from Teignmouth to Par; the two Irish divisions from Waterford to Skull Harbour (if Haulbowline Dockyard is being used). In each case the line to be strongest nearest the centre, so as to make it practically impossible that the wings can be cut off from the arsenal by a landing near the centre. Similarly, in Case II., the defence of Essex should be much stronger than Suffolk. And I need hardly say that I agree with Colonel Hickson that the part of our fortress garrisons allotted to inland forts should be used to defend the coast near those fortresses.

Why do we never discuss what we ought to do in case of a serious disaster to our battle fleet? Some bar any such discussion by saying that we must then treat for peace at once, forgetting that the terms we should obtain would vary with our power of offering further resistance. Such discussion can do no harm provided we preface it by agreeing that it must not lead us into any such large expenditure as might withdraw money from the Navy.

Any serious disaster happening to our fleet threatens us with two great dangers—invasion and scarcity. High prices might mean insurrection, if we do not find employment for those thrown out of work by that dislocation of our industrial system which even a partial blockade of Great Britain would entail. The preparation of complete plans for the fortification of our capital, arsenals, and coast would provide means of putting a large number of civilians to work at very short notice, and thus go far to meet both these great dangers.

With the above proposals I daresay that most of my brother officers will agree, but the question of how much money should be spent on coast defence is more open to question.

One hundred years ago our ancestors erected martello towers from Newhaven to the Suffolk coast east of Ipswich. Fifty years ago they strengthened the line in places, and prolonged it by erecting forts at certain small harbours. Are we wise to spend nothing on improving the defence of these coasts, seeing that the works erected by our ancestors are out of date, and that the development of railways and artillery has made the work easier? Personally, I believe that an expenditure of a quarter of a million a year on true coast defence would not prejudice naval interests, and would go far to completing our defensive system.

1st. The plans will cost little.

2nd. It is necessary that cross-over roads should be put in at about 12 places where we are likely to want to derail troops; otherwise the empty trains may find it hard to get back without delaying full ones.

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3rd. A few plantations are desirable, to screen the railways at certain points.

The above proposals would cost very little; and the following could be treated as arising out of the question of re-arming the territorial artillery, which question is pressing for settlement just now.

4th. We must evolve a good type of railway gun of about 5-inch calibre, and a system of indirect laying suitable to it.

5th. We should press for a much larger proportion of horsed 4·7-inch guns with the territorial artillery; it will be far more useful for both coast defence and fortress defence than field artillery. There is no need for the large number (9) of field batteries allotted to the territorial divisions. Owing to the custom of planting trees in our hedgerows, good artillery positions for a long line of batteries are seldom to be found in England.

6th. The volunteer garrison artillery of Kent and Essex should remain garrison artillery, and about 10 permanent batteries should be built for them and armed with two 6-inch guns each, at a cost of about £200,000. These are the coasts where Case I. and Case II. overlap, and which we should certainly have to hold if an invasion be threatened at all. The same number of 4·7-inch guns, with their necessary vehicles, harness, etc., would only cost about a fifth of the above to provide, though more to maintain. But still I agree with Colonel Hickson in thinking the fixed gun the better bargain for certain coasts, because of its remarkable superiority in range, accuracy, rapidity, hard hitting, readiness, and facility of ammunition supply. But I do not agree with him in thinking 9·2-inch guns necessary for true coast defence, for our object should simply be to keep the enemy's transports at a distance. The 6-inch gun will suffice for this, and if the enemy does force a landing, all the guns except those close to the landing place can be got away and re-used in the defence of London.

Let us discuss these questions in public, and then finish or prepare the needful plans in secret.

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COMMUNICATION IN THE FIELD.

By Capt. R. C. Hammond, R.E.

Thorough co-operation between all units of an army is essential for success in the field of battle, and it can only be possible when all the units are connected by a reliable and simple system of intercommunication.

Now that our army has been reorganized, and the division selected as the tactical unit, it should be of general interest to ascertain how far the organization of our communication units has been adjusted to suit the new conditions, and also to what extent their further reorganization may be desirable.

It will probably be conceded that a good system of communication must provide for the following requirements :—

(1). Maintenance of communication from the base to army headquarters, and from army headquarters to the component parts of the force.

(2). Lateral communications, where necessary, between different units.

(3). Internal communications within units.

Also that it must fulfil certain conditions, viz. :—It must be in harmony with the new divisional organization; it must be sufficiently elastic, so as to permit in any situation of the employment of that method of communication which will give the quickest results, combined with accuracy. For experience teaches us that no method is sufficient in itself, and, as occasions arise, one method may have to be replaced or assisted by another.

It is proposed first of all to describe the various means of communication available for military purposes and to consider the defects of our existing system of communication, and then to submit reorganization proposals for overcoming these defects.

I. Means of Communication Available for Military Purposes.

The following methods are available :—

(1). *Electrical,* including telegraphs and telephones.

(2). *Visual,* including flag signalling by semaphore, flag signalling by Morse code, lamp signalling, and heliographs.

(3). *Manual,* including foot orderlies, mounted orderlies, cyclists, and motor cars.

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To enable us to correctly appreciate the relative merits of the above methods, perhaps it would be well to give here a short description of each.

(1). *Electrical.*

There are two kinds of lines used in military telegraphy:—First, a conductor of bare wire supported on ebonite or porcelain insulators fixed to poles, buildings, or trees; and second, a wire conductor enclosed entirely within a non-conducting sheath of gutta-percha or india rubber. The former is called "airline" and the latter "cable." "Airline" takes considerably longer to construct than cable, but it is more reliable, and should always be employed where speed in construction is not of the first importance, and where a sufficiently permanent character is required to be given to the line. An "airline" wagon carries one complete office and five miles of wire, with the necessary poles and stores. The line can be built at an average rate of one mile an hour; this, however, will vary very much with the nature of the route. Twenty miles is a good day's work for four detachments, each detachment consisting of a commander and 11 working numbers, with three drivers and one wagon. The Morse alphabet is used with the short and long signals, commonly known as dots and dashes; and by this method a skilled operator will send and receive 25 to 30 words a minute. The usual custom is to work D.C. (double current) simplex, using a sounder and relay; when, however, this is not sufficient for carrying on the work, the carrying capacity of the line can be increased by fitting the offices for duplex or Wheatstone automatic, thus permitting the simultaneous transmission on the line of two or more messages. Another method of increasing the working capacity of the line is to make provision on the same wire for both Morse and vibration circuits, which can work independently of each other. This arrangement permits, if desired, the simultaneous use of telephone and Morse instruments.

"Cable" has simply to be paid out, and is allowed to rest on the ground. It is less reliable than "airline," as its position on the ground renders it particularly susceptible to faults and accidental breakages. It is only suitable where communication is quickly required for a short time, and if used in the first instance to save time in unsuitable positions, it should be replaced as quickly as possible by "airline." "Cable" should also be used for tactical purposes when the line has to be laid down and picked up again with rapidity. A cable wagon, with its attendant light spring wagon, carries 10 miles of cable, which can be laid at from four to six miles an hour; the process of laying the cable does not interrupt communication, as the operator seated on the wagon can send and receive messages whilst on the move. The instrument generally used with "cable" is the

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"telegraph set vibrating." This is portable, and can work efficiently through a cable which has but poor insulating covering. Telephone instruments are provided on both airline and cable circuits, and are useful for conversation between officers, or for persons not conversant with Morse code. "Airline" and "cable" are, of course, equally liable to be cut or tapped by the enemy, but faults can always be located and repaired very quickly.

Telegraphy, as a means of communication in the field, possesses several distinctive merits, in that it combines great speed and reliability with considerable rapidity of construction.

Permanent (P.O.) Lines.—In addition to constructing field lines, as above, the Telegraph Companies are prepared to take over and maintain all civil lines and offices in the theatre of war; and this necessitates a high technical knowledge of the instruments and systems employed in post office telegraphy.

Wireless Telegraphy is still in its infancy, and cannot yet compare in speed or accuracy with airline or cable; and as in addition it cannot be worked "duplex," its capacity for work is somewhat limited. It is very variable, and greatly affected by the constantly changing conditions of the atmosphere; also, from its nature, it is impossible to obtain the same security and secrecy as with wire conductors. We have every reason, however, to expect that in time many, if not all, of these defects will be removed, and that "wireless" will become of great practical value for military purposes. It will probably be found most useful in maintaining communication between ships and shore, between headquarters and advanced cavalry, or in similar situations, where topographical or tactical considerations would forbid the use of wire. Our military installations are now worked on a modified "Lodge Muirhead" system; one complete station is carried in a limber wagon, and can, under normal conditions, communicate with a similar station at a distance of 50 miles.

Telephones, for communication purposes, possess neither the speed, accuracy, nor reliability of the telegraph, and from their nature are unsuitable for the transmission of secret or code messages; they are very suitable, however, for use over short distances and by persons not conversant with Morse code.

Wireless Telephony is of still more recent origin than wireless telegraphy, and as our military authorities have apparently not yet taken official cognizance of it, it hardly comes within the scope of consideration in this article. Suffice it to say that the American Navy have recently carried out some very successful experiments in this direction. On one occasion constant communication by wireless telephony was maintained between the Navy Yard at Washington and the cruiser *Tennessee* at a distance of 12 miles. As a result the U.S. Pacific fleet have now been equipped with wireless telephone outfits.

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(2). *Visual Methods.*

Flag Signalling by Semaphore is an excellent quick method up to 1,000 yards, but if employed in the firing line, the sending operator must of necessity be more exposed than the Morse signaller, who uses a small flag whilst lying flat on his back.

Flag Signalling by Morse Code is practicable up to three or four miles with the small flag, and five to seven miles with the large flag. Both these methods involve a certain amount of manual labour.

Lamps.—The ordinary Begbie oil lamp can be used up to a distance of seven miles, the small limelight up to 12 miles, and the large limelight up to 22 miles; the two latter, however, are somewhat cumbersome, and all three have a wide cone of dispersion, and are liable to disclose one's position to the enemy.

Helios can be read at a great distance. The cone of dispersion is only 1 in 107, so they are not easily intercepted. They are, of course, entirely dependent on sunshine. An efficient signaller will read or send eight words a minute on the lamp or flag; where, however, the distance is so great as to necessitate transmitting stations, some corresponding delay is unavoidable. The chief points to be noted about visual signalling are that very little apparatus is necessary, no great technical skill is required, and there are no wires to be cut by the enemy; on the other hand, its efficient working is entirely dependent on the state of the atmosphere and the configuration of the ground, and it cannot compare in speed with the telegraph, especially over long distances. It has been found impracticable to maintain communication by visual signalling whilst on the move.

(3). *Manual Methods.*

Manual methods, such as foot orderlies, mounted orderlies, cyclists, and motor cars, will be most usefully employed over short distances, for conveyance of maps, photos, etc., and to carry to and from telegraph and signalling stations; also, in the event of failure of other methods, they may be temporarily resorted to for the whole duty of transmission.

Finally, in considering the merits of the above methods of communication, the arguments in favour of telegraphy appear to be overwhelming, and we may assume that it will be employed wherever possible. Still, it must always be remembered that each of the above methods may be of use under certain conditions. During the recent war in Korea the Japanese entirely depended on their field telegraph and telephones for conveyance of information; but when those broke down they had no alternative to fall back upon, and, as a result, communication was at times rendered extremely difficult or even impossible, and the execution of their operations rendered unnecessarily difficult.

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At the Battle of Yoshirei the wires of the Japanese field telephone broke, and having no visual arrangements for signalling, and the country being too broken for the movement of mounted orderlies, General Kuroki lost one of his most needed columns during the whole of that day's fight.

Again, at Phœnix Mountain, overlooking Feng-huang-cheng, General Fujii said to Sir Ian Hamilton "The signalling certainly seems to be a weak spot. I can quite understand how useful it would be to have a heliograph on the top of Ho-o-san (Phœnix Mountain) communicating with Antung and Wiju, but continental armies have also neglected visual signalling, and that is the reason our attention has not been sufficiently turned to the subject. No nation has practised this as much as you British, and, now that we have come to a country like Manchuria we see the reason why."

II. DEFECTS OF OUR EXISTING SYSTEM OF COMMUNICATION.

The composition of the field army for service abroad is to be—

1 Cavalry Division,
6 Divisions,
Army Troops,
Line of Communication,

as laid down in War Establishments for 1907—1908.

Let us now examine the system for communication duties in such a force, so as to see whether the distribution and organization is what it should be.

In the first place there is the telegraph system under the R.E., with its Director of Army Telegraphs at Army Headquarters.

Two telegraph companies on lines of communication are responsible for maintaining communication from the base to the advanced base. They utilize the permanent airlines as far as possible. Each company can erect and maintain 100 miles airline, with 10 offices.

Similarly two airline telegraph companies connect the advance base with army headquarters. Each company can erect 80 miles airline. There are also instruments and operators for 16 offices, and linemen for the maintenance of 160 miles of airline, including the 80 miles erected.

Two cable telegraph companies connect army headquarters with headquarters of divisions. Each company can lay down and work eight lines of cable 10 miles long, and three offices are carried for each line.

Two wireless telegraph companies connect army headquarters with cavalry headquarters, and also establish communication over country which is inaccessible to troops. Each company can erect and maintain four wireless stations.

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Six divisional telegraph companies connect divisional headquarters as far as possible with infantry brigades, and each company can lay and work two cables 10 miles long.

Regarding the above as a system for field telegraphy pure and simple, the organization seems excellent, and needs no further comment except as regards two points.

First, the establishment of the divisional telegraph company appears inadequate for the work which will be required of it. It will often happen that four lines will be wanted to maintain communication from divisional headquarters to the three infantry brigades and the divisional artillery respectively; and even granted that at times all four lines may not be simultaneously required, the great advantage of having an extra line ready to be laid out to meet new requirements will be quite sufficient to justify an increase of establishment. In this connection it must always be remembered that time must be occupied in reeling up a cable before it can be relaid in a different situation; and the human element must also be considered. Divisional telegraph companies are accustomed to work day and night when necessary, picking up and laying down their cables and working their offices, and often for days at a time men and horses get little opportunity for rest; but there is always a physical limit to the possibilities of endurance, and by cutting down the establishment of such a unit the capacity for work is seriously restricted.

The second point I would draw attention to is that there are no satisfactory means of conveying the messages, when received at an office, to the persons for whom they are intended. This duty is usually carried out by means of orderlies furnished haphazard from the nearest units. These men are not trained for the duty, and are under no immediate authority; the results, as may well be imagined, are most unsatisfactory. Messages do not reach their destination, and, in his anxiety to maintain touch with his brigade, the commander of a cable wagon is often induced to push too far forward into unnecessarily dangerous positions.

In connection with this it might be pointed out that the necessity for providing suitable escort or protection for cable wagons in advanced situations is too often overlooked; and they are thus exposed to great risk of capture by the enemy, when their services can ill be dispensed with.

This lesson was brought home to us during the last Irish manœuvres, when on more than one occasion the enemy's cavalry broke through our advanced posts and captured a cable wagon.

As regards training of *personnel*, the rank and file of the telegraph units may be roughly divided into three classes:—Office telegraphists (operators), who are in charge of offices and instruments; line telegraphists (linemen), who patrol and repair the lines; and drivers, who look after the horses.

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Both operators and linemen work together in constructing a line. The operators and linemen receive their training as follows :—

They first do a recruits' course of drill, musketry, and fieldworks at Chatham. They are then sent to one of the field telegraph companies, where for one year they learn construction of field lines (airline and cable) and the principles of working ordinary telegraph instruments. They are then attached to K Telegraph Company for practical instruction in the working of permanent (P.O.) lines. They then return to a field telegraph company for duty during the next training season and for manœuvres. After this, men who are sufficiently qualified and recommended are instructed at the S.M.E. in the more advanced knowledge required by permanent linemen, and in the use, adjustment, and maintenance of the more complicated telegraph and telephone instruments. The result is that all R.E. telegraph units have a very highly trained and efficient *personnel.*

The drivers are enlisted at Aldershot, where they undergo some preliminary instruction ; they then join their field unit, where their training is completed.

It is found a good plan to teach the sappers to ride, and to give the drivers a slight knowledge of line work, as the men are thus more generally useful and available to replace casualties. The men are encouraged in this respect by being granted extra pay according to their qualifications.

Next as regards *matériel.* The new cable wagon is, except for its weight, a great improvement on the old cart. The only adverse points to note are :—There is no automatic arrangement on the airline wagon for winding up airline ; there are not sufficient P.O. instruments provided for instructional purposes ; there is no money grant to assist officers who may wish to investigate and experiment with new instruments and appliances.

The next point to consider is the visual signalling.

The signalling system of the field army is under the Director of Army Signalling at army headquarters.

Divisional signallers are intended to supplement the cable lines laid by R.E. to brigade headquarters, should the latter fail : and brigade signallers to communicate from brigade headquarters to battalion headquarters, and to supplement the infantry telephone lines from brigade headquarters to battalion headquarters.

The establishments of signallers are laid down in *War Establishments,* but it is difficult to see how they will prove sufficient to provide terminal stations at brigade and divisional headquarters. Two examples are taken at haphazard to exemplify this. Turning to page 27, *War Establishments,* we find the signallers allowed for headquarters, cavalry division, are 1 officer, 3 operators, and 1 man, to hold five horses. Now a cavalry division has four cavalry brigades, each of which in the field may, and at the same

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time, require to communicate day or night with divisional headquarters. Again, on page 34 we find the establishment allotted to headquarters, divisional artillery, is three signallers and one horse-holder for communication with three R.F.A. brigades, a howitzer brigade, and a heavy artillery battery. It would seem difficult, with this establishment, for a C.R.A. to maintain communication in battle with his brigades; and yet the lessons of the last war show us the great importance of artillery control. The same applies to the establishments of signallers for infantry brigades and divisions (p. 29.—Infantry division: 1 officer, 1 sergeant, 5 operators, 1 horse-holder; p. 32.—Infantry brigade: 1 officer, 4 signallers).

Signalling stations are under the same disadvantages as telegraph stations, in that orderlies for the conveyance of messages are only provided haphazard from any troops which may happen to be handy, without any reference to their fitness for the duty.

In referring to the establishments of brigade and divisional signallers the writer has used the term inadequate, but he might almost have said non-existent, for there is no such thing as a permanent body of brigade or divisional signallers, and they are only brought into existence when required by collecting them from different regiments. The result of thus extemporizing a signalling staff for brigade and divisional services is that the men are not fitted to work together, and that units are depleted of a proportion of their men at a time when they can least spare them—a most faulty and pernicious system, which leads to considerable friction.

The Training of Signallers, like their organization, is entirely regimental, a number of men in each unit being instructed by the regimental instructor and assistant instructor.

Certain officers and N.C.O.'s are sent from all units for a course of instruction at one of the army signalling schools, so as to qualify as instructors and assistant instructors of signalling for their units. The length of each course is about two months, during which time they are instructed in telephony and all the methods of visual and manual signalling. The central school is at Aldershot, and is supplemented by six temporary schools in various parts of Great Britain, South Africa, and India.

The efficiency of the regimental training within units is greatly prejudiced by the difficulties under which it is carried out. There is, in the first place, a difficulty in getting volunteers, owing to the attractions of regimental employment carrying better pay, and to the fact that signallers are not excused general duties. Then, in consequence of the limited time available, the instruction is often necessarily restricted to visual signalling, when it might otherwise be made more varied and interesting by the addition of some map-reading, and messenger and telephone work.

Telephones are now much employed on field operations, but this is

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in many cases owing to the initiative and generosity of individual officers. There is not, to the writer's knowledge, any generally recognized system for their employment, nor are any telephonists mentioned in *War Establishments*. Sometimes telephones are worked by the R.E., and sometimes regimentally.

At the commencement of the Russo-Japanese War, as is the case with us now, a very large proportion of the telephones used in the Japanese army had been provided by individuals; afterwards, when their extreme usefulness had been sufficiently demonstrated, the Japanese Government took them over and reimbursed the money that had been expended. Possibly our Government may see its way to improving on the example set by our allies, by providing the necessary telephonic equipment before our next war proves it to be necessary.

It should be particularly noted that the telegraph and signalling systems are quite separate, and that it is a most difficult matter to ensure any co-operation between them. Consequently, they are not always worked to the best advantage; and when it becomes necessary to send a message by the quickest possible way, it is sometimes very difficult to know which will be the best method to employ.

The following "concluding remarks" from a memorandum on this subject, lately issued by the General Staff, Aldershot, will bear repetition:—"One thing cannot be too strongly impressed on commanders and their staffs; and that is the great importance of organizing all services for the transmission of orders and information, *i.e.*, telegraphs, telephones, visual signalling, and orderlies, under one authority within each unit of command; and the necessity for the employment of specially selected and highly trained *personnel* for the service. The economical use, under varying circumstances, of the means of transmission provided, requires a close study and thorough grasp of the subject. If the subject is not thoroughly understood; and if, in the field, the various commands and arms of the service are not linked up scientifically and economically by means of the telegraphs, telephones, etc.; then it would be far wiser to return the *personnel* to the ranks, to handle a rifle, and to save the expense of the equipment."

The question also of intercommunication between the naval and land forces appears to have been lost sight of, though on occasions it might be required. It would usually be effected by visual signalling or wireless telegraphy. The former would present no special difficulties under favourable conditions of atmosphere, etc.; but, with regard to the latter, there is at present a regrettable absence of co-operation and interchange of ideas between the two services. This may, possibly, be due to the fact that, whereas the Navy

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employ Marconi's system, the Army favour the Lodge Muirhead system. The importance, however, of being able at any time to establish wireless communication between ships and shore is such as to warrant every endeavour being made to overcome the above difficulties, and to afford opportunities of practising this form of communication.

In conclusion, therefore, some grounds seem to exist for the following criticisms on the present system of communication, viz. :—

(1). Establishment of divisional telegraph company insufficient.

(2). (*a*). Training of signallers not sufficiently comprehensive.

(*b*). Establishment of signallers for brigade and divisional services inadequate.

(*c*). Brigade and divisional signallers, not being a permanent body, have to be found from regimental signallers; and the consequence is that they are unfitted to work together: also, that units are depleted of men at the time when they are most required.

(3). No trained orderlies available for employment at telegraph and signalling stations.

(4). No organization for telephone lines has yet been adopted for the whole army.

(5). No co-operation between telegraphs and signallers; nor are either of these systems of communication sufficiently assisted by manual methods.

(6). Insufficient co-operation between naval and military forces.

III. PROPOSALS FOR REORGANIZATION.

Such being the defects of our existing system, it becomes advisable at this stage to consider the best means of amending them, and the following scheme is put forward as offering a satisfactory solution of the difficulties that have been pointed out.

First of all, it is suggested that the whole problem of communication be entrusted to one communication* corps, so as to combine all the methods available to the best advantage. This corps to be under the direction of a permanent chief, a general officer on the headquarter staff, who would be responsible for all communication work throughout the Army, including telegraphs and signalling.

* It is admitted that the term "communication" may be somewhat inappropriate and almost misleading, but the writer has failed to discover a word which can be more suitably applied to the transmission of messages by telegraphs, signalling, and messenger work.

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On the headquarter staff of an army in the field there would be a Director of Communication Units, who would combine the authority and duties of the present Director of Army Telegraphs and Director of Army Signalling.

The units composing this corps would be the R.E. telegraph units as at present organized, but with the addition to each of a signalling and messenger detachment, with the necessary equipment. This would greatly increase the sphere of usefulness of each unit, and make it more self-dependent. This corps would have the entire responsibility for the maintenance of communication from the base to army headquarters, from army headquarters to headquarters divisions, from divisions to brigades, from brigades to battalions, from division headquarters to divisional artillery; also, where necessary, laterally between divisions and between brigades.

But it would have nothing to do with the *internal* communications of infantry battalions, or of artillery or cavalry organizations, which for tactical and disciplinary reasons would be best worked by the units themselves, under arrangements made by their own C.O.'s. Similarly, in the important subject of communication between infantry in the last phase of an attack and its supporting artillery, the C.R.A. ought to be entirely responsible for its maintenance. At this period of the fight, when the opposing infantry come to close quarters, it is necessary to supplement the regular channel through the divisional headquarters by a direct line of communication between the infantry and artillery. This could usually be effected by sending forward, from each field artillery brigade, an observation post of five men, under an officer. This patrol would take up a position, either with the brigadier or in advance of him near the firing line, and would communicate with the guns by telephone, supplemented by visual signalling and orderlies. This and similar questions of internal communications within units demand the earnest consideration of the C.O.'s concerned, but they hardly come within the scope of this paper.

The composition and scope of responsibility of this proposed communication corps having been generally indicated, a detailed description of the communications of a division organized according to the proposed plan is given by way of further illustration.

In place of the present divisional telegraph company, and divisional and brigade signallers, with their inadequate establishments and lack of cohesion, there would be one divisional communication company completely equipped with every available means for maintaining communication, electrical, visual, and manual. Each company to be under one controlling head, viz., the divisional communication officer, who should be a major on the divisional staff, and in the confidence of the general.

The establishment suggested would be a major in command, assisted

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by a captain, four subaltern officers, and 236 rank and file, destributed as under :—

	Rank & File.
1 Headquarter section (pay-sergeant, C.S.M., C.Q.M.S., clerks, farriers, collarmakers)	12
4 Field sections, *each* under a subaltern and composed as under :—	
1 Field telegraph detachment (cable and light wagon, two buzzer offices, 10 miles line) ...	12
1 Signalling and orderly detachment (four signalling squads and 20 orderlies)	44
	56
Total—four field sections	224

The equipment required in each section of the above company, for the use of the signalling and orderly detachment, would be eight sets signalling equipment (helio, lamp, flag, telescope) and eight portable telephones (like Medhurst pattern), which could be used on specially laid telephone lines, or for tapping in on the telegraph cables ; also light telephone wire (about 12 lbs. to the mile), which could be simply cut and left behind if necessary.

Each man would have to be provided with some means of locomotion, bicycle, motor-bicycle, or horse.

As regards the training of the signalling and orderly detachment, it is only necessary to note that, being freed from general duties, the men would have a much better chance of becoming proficient, and, in addition to being signallers, would be taught map reading, and be practised as cyclist orderlies, despatch riders, and telephonists. This would make them more generally useful and the instruction more interesting.

The divisional communication officer, after receiving his instructions from the general, would dispose his company to the best advantage. Assuming that the cable company had succeeded in connecting up divisional headquarters with army headquarters, the correct procedure for the divisional communication officer to follow would be to establish, by means of his telegraph detachments, three "communication posts" as near as possible to the larger units of the division ; and, by means of his signallers and orderlies from these communication posts, to maintain constant touch with each unit. The commander of each communication post would keep him constantly informed as to what units he was in touch with. The distribution of these communication posts would be made known to the troops as early as possible, so that each unit would know the distance and position of each communication post, which distance would rarely be more than a mile. Three communication posts only are suggested ; because

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usually this number would suffice, and the communication officer would often find it useful to keep one cable wagon in reserve, to maintain touch with the general, should the latter change his position, or to establish lateral communication with another division, or to meet any other contingency.

Exactly the same procedure would be carried out while on the march. The cable wagons would keep as near as possible to the headquarters of their respective brigades, messages would be received and despatched on the move, and the cyclists and mounted orderlies of each section would be available to instantly convey messages, thus received, to their actual destination.

From this it will be seen that the divisional communication officer can remain at the headquarters of the division, and yet maintain absolute control over his unit. He can distribute his unit according to the situation, he can make full use of each means of communication, and, whenever necessary, he can, without reference to anyone, duplicate or replace one method by any other.

Similar but less extensive changes would be required in the cable and airline telegraph company. Their chief aim and object will always be to work their cables, airline, and permanent (P.O.) lines to the utmost, and in that respect their present organization is wholly admirable, and cannot be improved on. But the addition of a signalling and orderly detachment to each company would increase its range of power, facilitate the rapid and reliable delivery of messages, and afford an alternative method of transmission in case of a temporary interruption of the telegraph.

It will constantly happen that one communication unit may be able to help another, or that a transfer of *personnel* or *matériel* from one unit to another will become desirable. With all these units under the control of one head, the director of communications, these changes could be expeditiously and smoothly carried out under his orders, and perfect co-operation throughout the whole system would be ensured.

To be in accordance with the rest of the scheme, it is suggested that the signalling schools should be taken over by the R.E., so as to be under the same control and in harmony with the communication units. They would still be required as schools of instruction for regimental instructors and assistant instructors: the system of instruction in vogue is excellent, and the only alteration proposed would be to increase its scope by giving classes an insight into telegraph work, which they cannot at present receive.

It can hardly be fairly urged against these proposals that they are too destructive, for the abolition of the present system of borrowing signallers from regiments for brigade and divisional duties would certainly be welcomed by C.O.'s, and would be entirely in the interests of the individual units.

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Before concluding, notice should be taken of a suggestion which has been made that the signallers should take over the telegraphs and the whole duty of communication from the R.E. Extraordinary as this proposal may at first sight appear, it may possibly be accounted for as follows:—Officers of other branches of the service, constantly seeing our cable wagons at work with troops in the field, are, not unnaturally, apt to get the impression that cable work is the sum total of telegraph work in the field; whereas, in reality, it is but a small and the most elementary portion of it. The objections to the proposal are very strong. They are these:—That the signallers have never been organized in a permanent body for other than regimental work, and do not possess the technical knowledge and experience necessary for conducting a telegraph system; that the R.E. telegraphs, on the other hand, have for long existed as a permanent body, well organized for its work, and capable of fulfilling the demands made on it. This in itself would appear to be sufficient reason for entrusting to them the whole duty of communication; but, in addition to this, since the telegraph is the most efficient means of communication at our disposal, and would, whenever possible, be used in preference to any other alternative, it is only natural to suppose that any combined system of communication would be best conducted by men practised in telegraphy.

It is encouraging to note that the authorities in the Irish command have clearly indicated their determination to grapple with this problem of communication. It is not a year since the telegraph companies were first sent there, yet they have already, during the summer training, been afforded many opportunities of doing useful work; and classes have now been started at Limerick, during the winter months, to enable officers of other branches of the Service to obtain an insight into the methods of telegraph work.

In conclusion, it is only to be hoped that some of the proposals put forward may be given a trial. If on any divisional manœuvres a signalling and orderly detachment were placed at the disposal of the O.C. Telegraphs, it would be quite possible to extemporize some such divisional communication company as above advocated, and to test its value for work. The practical lessons thus gained could not fail to be of incalculable value, and would materially contribute towards the object we have in view—the perfect efficiency of our communication units.

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THE FOUNDATION OF THE ROYAL ENGINEER ESTABLISHMENT AT CHATHAM.

By LIEUT.-COLONEL B. R. WARD, R.E.

II.

PASLEY'S METHODS OF INSTRUCTION AND FIRST TEXT BOOKS.

"It has been my object," writes Pasley in the preface to the first edition of his *Essays on the Military Policy and Institutions of the British Empire*, "to endeavour to analyze the spirit of military policy and institutions in general, so that if I have succeeded in the enquiry something may be found applicable to all times and circumstances"; and this generalizing tendency of Pasley's mind, so remarkably displayed in the essay as a preliminary to sound practical deductions, is equally exhibited in his educational ideas.

Personal experience and conversation with brother officers in the Corps had strongly impressed the fact upon him that well-instructed and intelligent sappers were the greatest need of the R.E. Department. Well-educated foremen were at that time not uncommon in civil life, and he saw no reason why they should not be trained up to a similar standard in the army.

His ideas on the subject may be deduced from the "General Observations" in the first text book which he published for the use of the S.M.E. in 1814.

He begins by pointing out that whilst everyone who has given any attention to the subject realizes that foremen and overseers in civil life have some knowledge of practical geometry and can understand plans, sections, and models, officers of Engineers must own that such a standard is seldom found in the army. It is true that during peace time the disadvantage of this want of knowledge is not very evident, as there are always several civilian overseers and foremen whose assistance can be readily obtained. But in war time the case is very different, and Engineer officers have "scarcely any resource but their own individual exertions." Even when military artificers, drawn from the Line, are put under the Engineer officers' orders they are less skilled than the men of the R.E. Department.

He next analyzes the reason for the civilian's superiority in skill, and finds it due either to better education at the start or to diligence and ability of the men themselves, but he points out that both these

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classes would object to enlist in the Department even if the pay was doubled or even trebled. Artificers who enter H.M. Service are imperfectly instructed, and their pay being fixed and their life unsettled, they have not the same mental stimulus as the civilian, who may either "rise to affluence or sink to poverty or distress in proportion as he cultivates or neglects his abilities."

Some superficial observers suppose that this comparative ignorance is due to incapacity, but Pasley lays down as a maxim that in any body of men, however collected, there is always a latent fund of superior talent, which if properly trained may be used to the advantage of the State. In the case of military men, although they have less stimulus than civilians to strive for individual improvement, their habits of discipline and the emulation which can be so easily roused make it easier to improve them as a body, if only their instruction is carried out under the eye of a zealous superior.

Pasley ends his "observations" by saying: "If the remarks upon the causes of the comparative ignorance and consequent inefficiency of the R.E. Department are allowed to be just, it must also be admitted as a natural inference that there is no possible mode of collecting, forming, and keeping up a body of well-educated and efficient military artificers, except by instructing them according to some properly digested system after they enter His Majesty's Service."*

From the above it is evident that Pasley thoroughly realized how the military habits of discipline and obedience, combined with soldierly pride and emulation, formed the psychological basis upon which a zealous commanding officer might erect a solid educational structure, and he cast about accordingly for some well-digested system of education by means of which such training could be carried out. The system which he ultimately decided to adopt was one initiated by Dr. Andrew Bell, a clergyman of the Church of England, and at the time one of the most prominent educational authorities. This divine, in 1789, whilst chaplain at Fort St. George, Madras, had interested himself in instructing the orphan children of the Military Asylum, and in order to counteract the lack of teachers, had hit upon the expedient of making the older pupils help to instruct the younger. So pronounced was the success of this idea that, on his return to England in 1797, he published a pamphlet on the subject, and in the following year a school, conducted on his principles, was started at Southwark. The success of the experiment ultimately attracted so much attention that Dr. Bell was called upon to organize a school system based on "monitorial" lines. Pasley, in 1811, visited one of the schools so organized, and resolved at once to apply the system to the training of his N.C.O.'s and men.

* Pasley's *Course of Instruction, originally composed for the Use of the Royal Engineer Department.* John Murray, 1814, Vol. I., p. 215.

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The experiment proved so successful with his Plymouth Company of Artificers, that he submitted proposals to a committee of R.E. officers for carrying it out on a larger scale, and had the satisfaction of finding them officially approved by the issue of the Royal Warrant of the 23rd April, 1812, authorizing the Establishment at Chatham. He first turned his attention to instructing the N.C.O.'s and men in practical geometry, so as to enable them to understand a rough sketch plan or section, and, as he himself says, his method of teaching the subject was similar in principle to the methods laid down by Dr. Bell.

Pasley has embodied, in his first text book written for the S.M.E., the methods he employed for teaching practical geometry and fortification, and his "Directions and Observations respecting the Best Mode of Instruction" are considered of sufficient interest to quote *in extenso*.

"In carrying on the course," he writes, "the learners should be placed in rows, upon forms or benches, with narrow tables before them, and a stage or platform should be raised at one end of the room for the teacher to stand upon whilst he delivers his instructions, in order that the whole class may be able to see distinctly everything which he writes or draws upon the board.

"The teacher must always give the word '*attention*' previously to reading any definition, order, or remark from the book, and ought to take particular care to see that this caution is obeyed. He should read everything in a loud voice, and in a slow, clear, and distinct manner. It is also often proper to read the same definition, caution, or title of a problem twice over.

"When it is proposed to commence teaching a set of men totally uninstructed, they must be divided, either by sitting on distinct seats or otherwise, into parties of not more than six or eight men each. In a very short time, three or four days for instance, the teacher will be able to distinguish the difference of talent in the learners, and will accordingly place those men who show most ability and attention at the head of their seat or class, who will from that time be called monitors. Until he ascertains who are the most fit for monitors he must inspect the performance of every man himself. Afterwards he will inspect only the performances of these monitors. If he finds that they have understood his directions and executed them correctly, he will order them each to inspect their seat, which will be done accordingly; but if any monitor should be wrong he will go on inspecting the performance of the second, third, or fourth man of the same seat, and whoever is right must be immediately promoted to the head of the seat, in place of the former monitor.

"In this manner one teacher may instruct 30 men at the same time with great facility. For if we suppose these men to be placed in five seats or rows, or otherwise to be divided into five parties of six men each, then there will of course be five heads of seats or

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monitors. The teacher will consequently have to examine the performances of five monitors, and each monitor will have to examine five learners."*

Later on Pasley gives directions as to how *vivâ voce* examinations of the class should be periodically carried out, explaining the necessity for such examinations in the following words :—

"If the teacher were to go on, according to the method which is most proper at the commencement of the course, reading and exemplifying everything, without requiring explanations, and examining the learners from time to time, although it would be impossible for any of them to be idle, as far as regards the practical operations, yet some of them would, in all probability, content themselves with copying the figures drawn upon the board step by step, without endeavouring to understand the whole chain of operations in the problems they performed, and without attempting to remember, or perhaps even without listening to, the various definitions and remarks read by the teacher.

"The consequence of this is that at the first examination those who have not paid proper attention are sure to expose their ignorance in an unpleasant manner, whilst the more diligent men distinguish themselves by the ability and readiness of their answers and the accuracy of their operations. In order to avoid a similar mortification, every man who has failed once will exert himself to the utmost before a new examination takes place.

"Although a body of men may have commenced at the same time, it may be proper after a certain period to divide them into two classes, placing those who are most perfect in the first class and allowing them to go on regularly with some new portion of the course, whilst the others may be made to do the whole or some part of what they have already performed over again.

"Whenever a body of men are under instruction, if they are allowed to change their seats at will or to sit in the same order in which they placed themselves at the commencement of the course, it will often happen that four or five men of very superior abilities may all be seated together, whilst in some other seat most part of the men may be below par in point of capacity. If they remain in this confused state it will be difficult or impossible to judge truly of the comparative ability of the learners, which, in the R.E. Department, it is very important to ascertain. The teacher must therefore endeavour to put all the seats on a par by dividing the men of abilities as equally as possible amongst them. This may easily be done in the course of a few days, or at least after the first examination, and is an object which should be kept in view throughout the whole course. After any arrangement has once been made for this purpose,

* Pasley's *Course of Instruction*, Vol. I., p. 198.

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the teacher should not allow the men to change seats without his order or permission."*

The efficacy of this method of training N.C.O.'s and men was thoroughly proved by the experience of war, and in the preface to the second volume of his *Course of Instruction* (viz., a treatise on fortification) Pasley refers to its success. He writes that the men thus instructed have been found of the greatest service owing to the knowledge they had acquired. They were not only able to execute fieldworks with greater skill and despatch, but also assisted the officers of Engineers in superintending working parties. "Indeed," he adds, "on all occasions in which works are carried on upon an extensive scale the latter is by far the most important and useful manner in which the men can be employed. For example, no less than about 18,000 peasants and 2,000 horses worked, by order of the Duke of Wellington, under the direction of officers of the Royal Engineers, in improving the defences of the frontier of the Netherlands, for some months together, immediately before the great victory of Waterloo; and, by all accounts, the extensive works then in hand were conducted with the greatest regularity and despatch. Now, it may easily be conceived that to have directed such a great body of workmen to proper advantage, by means of a few officers of Engineers, would have been utterly impossible but for the system adopted, of subdividing the various work amongst the non-commissioned officers and privates, each of whom was made responsible for laying out the details of his own portion, and for the direction of a party of from 20 to 100 men, or even more, according to circumstances. During the last year of the Peninsular War, and in the various recent operations in Canada, the same system had been constantly practised with equal advantage, the non-commissioned officers and men of the R.E. Department, who were employed as overseers of military working parties, having on all occasions given the highest satisfaction. Nor has their superior knowledge rendered them presumptuous or intractable; on the contrary, it has evidently produced the most favourable effect upon their character and conduct, and as far as regards personal exertion, it is generally allowed that these men, although mostly composed of artificers, will, with equal ease to themselves, perform nearly twice as much work as any common working party of the same numbers, furnished by other troops, who have not been previously habituated to the construction of fieldworks.†

"Owing to the very recent introduction of the system described, the trained Sappers and Miners were not brought forward in sufficient numbers in any enterprise of importance before the siege of St.

* Pasley's *Course of Instruction*, Vol. I., p. 213.

† Pasley's *Course of Instruction, originally composed for the Use of the Royal Engineer Department*, Vol. II., p. vi.

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Sebastian, in which they distinguished themselves. At the assault of Bergen-op-Zoom, in March, 1814, the Royal Sappers and Miners, headed by a lieutenant of Engineers, cut down the palisades, crossed the ditches, planted the ladders, and were the first troops that mounted the enemy's ramparts. At Peronne, a place taken by storm after the Battle of Waterloo, they also had the honour of leading the assault. But the most remarkable instance of the advantages arising from having men of this description was in the siege of Fort Boyer, on the coast of America, which was attacked by the British troops after their failure before New Orleans. The first night of the operations soldiers of the line only were employed. From a want of skill and experience in the nature of the duties required of them, and there being very few Engineer officers to direct, they collected in groups instead of being spread out, as they ought to have been. Consequently, out of one small party of 20 men, 14 were killed and wounded by a single discharge of grape shot, and such confusion ensued that very little progress was made in the course of that night. On the second night of the siege nine men of the Royal Sappers and Miners were employed in addition to the troops of the line. By the assistance of these few individuals the officers of Engineers were enabled to regulate their working party to so much advantage that before morning they had completed a parallel of 200 yards in extent, within 50 yards of the enemy's works, besides approaches in advance, which being filled with sharpshooters, the Americans were unable to show themselves at their guns, and the fort surrendered. It is proper to explain that, as the army sailed from the Mississippi in divisions, the main body of officers and men of the Royal Engineer Department had not arrived at the period of the above attack. The nine men who so particularly distinguished themselves happened to be on the spot before the others, because, being all carpenters by trade, they had been lent to the admiral for the purpose of repairing the boats of the fleet."*

Nor is it only from Pasley himself that we learn the enhanced value of the Royal Military Artificers, whose name was changed to "the more martial appellation of Royal Sappers and Miners"† simultaneously with the move to Chatham in 1812.

Sir John Jones, in his *Journals of Sieges in Spain*, writes: "This change of name operated like magic. Everyone in an instant saw the propriety, nay, the absolute necessity, of the whole body being instructed in sapping and mining, and an institution was created by Lord Mulgrave for that purpose at Chatham.

"The formation of the institution at Chatham was followed by another simple change of equal or even paramount utility, viz.,

* Pasley's *Course of Instruction*, Vol. II., p. ix.
† Pasley's *Course of Instruction*, Vol. II., p. v.

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obliging the officers of Engineers, whilst amongst a stated number of the junior of the several ranks of 2nd captain, 1st lieutenant, and 2nd lieutenant, to be for that period actually the regimental officers of the companies of Sappers.

"This measure, by linking together the officers and men, and closely connecting their mutual interests, gave discipline and pride to the soldier, whilst it conferred the utmost benefit on the Engineers, by obliging each officer, during three periods of his military service, to perform regimental duty and to acquire due experience in the drill, discipline, and interior economy of troops. On the strict and impartial observance of this rule, and making every officer take his chance of the station and service on which his company may be employed during the whole period of his being on the list for regimental duty, the efficiency of the Corps of Sappers and Miners, and the zeal and assiduity of the officers, will ever mainly depend. Neither commanding influence nor petty favouritism should be allowed to interfere with this regulation.

"The company at St. Sebastian was the first which entered the field after these great changes, and the men were found useful and intelligent. Since that time each company has been instructed in succession, and a detachment of greater or less strength has borne a useful part in all the military operations of the empire. * * * Indeed justice requires it to be said that these men, whether employed on brilliant martial services or engaged in the more humble duties of their calling, either under the vertical sun of the tropics or in the frozen regions of the north, invariably conduct themselves as good soldiers, and by their bravery, their industry, or their acquirements, amply repay the trouble and expense of their formation and instruction."

So much for the system. Speaking of its originator, Sir John Jones adds:—"On this point it may be observed that a most happy selection was made of an officer as Director of the Institution at Chatham in Lieut.-Colonel Pasley, who, uniting great zeal and unwearied perseverance to good talents, has succeeded in extending the course of instruction far beyond the original objects of the institution, and has filled the ranks of the Sappers with good scholars, good surveyors, and good draughtsmen"; * and such words, penned as they are by so keen and able a critic, plainly show how Pasley's worth and ability were recognized even in those days, before the final test of time had shown the lasting excellence of his system.

* *Journal of Sieges in Spain*, by Major-General Sir John T. Jones, Bart., R.E., 3rd Ed., 1846, Vol. II., p. 347.

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TRANSCRIPT.

THE SERVICE OF AERONAUTS IN WAR.

From an article by A. Vegener in the January, 1907, number of the *Eenzhenernee Zhoornal*).

THIS article is compiled from notes made by the author when serving with the 1st East Siberian Field Aeronaut Battalion and in the Instructional Aeronaut Park, and, after having been passed for revision to the Commandant of the Instructional Park, it is now published, in hopes that it will provoke useful criticism from those interested in ballooning matters.

ORGANIZATION.

At present there exist in the Russian Army the following aeronaut units :—The Instructional Park, 3 East Siberian Field Battalions (Omsk, Irkutsk, Nikolsk-Ussurisk); 2 Fortress Companies (Yablonna, Vladivostok) and 6 Fortress Detachments (Varshava, Novo-Giorgievsk, Ivangorod, Kovna, Ossovets, and Brest-Litovsk).

The objects of the Instructional Park are laid down officially as follows :—(1), Theoretical and practical instruction of officers temporarily attached, and of rank and file permanently attached to aeronaut units; (2), for carrying out experiments and testing inventions in ballooning; (3), preparation and safe custody of equipment; and (4) the forming in war time of new field units and completing the *personnel* and *matériel* of all existing units.

An aeronaut battalion consists of 19 officers, 673 rank and file, 333 horses, and 250 carriages, and is formed of a headquarters and two companies.

Each company is equipped to send up simultaneously one captive and one signalling aerostat; in exceptional circumstances, however, a single company can supply two separate captive aerostats, with separate forces.

A company with filled balloon is divided into two échelons. The first échelon includes the balloon, one or two gas-holders, with spare gas, a winch wagon, one or two wagons containing accessories for use during ascents, and the travelling kitchen. The second échelon contains the gas-generating apparatus, wagons containing materials (aluminium and caustic soda) for three fillings, various other balloon equipment, and the supply wagons.

The battalion headquarter detachment includes the commandant and his staff, the medical carts and ambulances, tools, armourer's wagon, a travelling kitchen, and the second line transport.

In addition to the above a battalion takes on service a supply of spare equipment and materials for 60 fillings. This is generally left at the base, and drawn on as required. For transport the chemicals alone

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require about 450 two-horsed, four-wheeled wagons, or 1,000 single-horsed, two-wheeled carts, or 19 railway trucks.

On service it is intended that a battalion shall be posted to each army corps, and the companies can be detailed to divisions or other detached forces, as required.

The duties of the senior officers in a battalion are as follows:—

The Commandant is immediately subordinate to the Chief of Staff of the Army Corps. Besides his disciplinary duties, he must look to the maintenance of the stores and equipment of detailed companies, but must not interfere with their work. He is included in (and can be the chief of) the reconnaissance section of the army corps staff, by whom all the reports and information sent from the balloons are collected. He must keep the companies posted in the latest information concerning the progress of the campaign, and must supply them with the latest maps and plans. If the army corps staff requires any special observations to be made by a detached company, the order for such work must be sent by the Commandant through the staff of the force with which the company is detached. He will also help the company commanders with his advice and occasionally call meetings of his officers, to consider any technical questions which may arise.

Immediately under the Commandant are the second in command and the quartermaster, the former of whom superintends the technical training of the companies, and the latter looks after their supply and equipment.

The company commander, on detachment, is immediately subordinate to the Chief of Staff of the force to which he is attached. Besides the ordinary command and instruction of his company, he must keep the battalion headquarters informed of his requirements for replenishing his store of materials and equipment. He must ascertain the latest information about the progress of the campaign, and should keep his officers and some non-commissioned officers informed of it; and he must also obtain the latest maps. He details a substitute to act in his absence.

The four company officers should be detailed as follows:—No. 1, in charge of the gas-generating apparatus; No. 2, in charge of the balloon equipment; No. 3 is transport officer, and looks after the horses and wagons; and No. 4 acts as his assistant. When the balloon is in use these officers should form two reliefs, Nos. 1 and 3 working together, and Nos. 2 and 4 forming second relief. But this arrangement can be varied at the discretion of the company commander.

The duties of the officers of fortress units are similar to the above; but the Commandant has himself to perform the duties which devolve on the second in command and quartermaster of the field units, and the company commanders are in this case replaced by station commanders.

WORK IN THE FIELD.

Reconnaissance from aerostats depends mainly on the state of the weather; strong or gusty winds lessen the height of the ascent, render observation difficult, and can even make the ascent of the aerostat quite impossible.

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Observing is possible from balloons when the force of the wind does not exceed 6 to 7 mètres per second, and from kites when it does not exceed 15 mètres per second. When the strain on the anchoring rope of a kite aerostat exceeds 1,500 kilograms, ascents cannot be carried out.

With winds of greater strength, and in gusty weather, the aerostat oscillates to such an extent that observing becomes impossible. Fog, snow, rain, or low clouds limit the field of view, and may render observing impossible. In thunderstorms ascents are dangerous.

It is only in exceptional circumstances that observing can be successfully carried out at distances exceeding 4½ miles; but white tents can be seen up to 6 or 7 miles, and camp fires by night up to 10 or 12 miles. Local objects, such as woods, and also steep slopes, impede the survey of ground, the more so the higher they are, the greater the distance, and the less the height of the balloon ascent.

A captive balloon in exceptionally favourable circumstances, and in a dead calm, can ascend to the height of 800 to 1,000 mètres, but balloon ascents do not generally exceed from 200 to 500 mètres, and kite ascents from 500 to 600 mètres.

Aeronauts can be used for reconnoitring, correcting the fire of artillery, signalling, and, in exceptional circumstances, for free runs. All orders for work should be either given or confirmed in writing, and a great point is made of keeping copies and records of all orders received, work done, and reports and sketches sent in by the balloonists, as these are required when compiling the report on the work of the unit at the end of the campaign.

The duties of a company commander, on receipt of an order to carry out a reconnaissance, include the following :—

(i.). He must decide on the place and time for filling the balloon. For making hydrogen, water is essential, and therefore the place must have a good water supply. The water need not be fit for drinking, and may even be sea-water, and the quantity required for making and cooling the gas is from 3,000 to 4,000 gallons per hour. Most of this can be used a second time, but after it has been passed through the refrigerator it becomes unfit for drinking, and therefore the place chosen, if on a stream used for other purposes, should be below the horse watering troughs. It should be beyond the range of the enemy's artillery fire, and yet not more than 2½ to 3 miles from the place chosen for the ascent. Plenty of time must be allowed for filling the balloon; the operation for a balloon of 640 cubic mètres, by the alkaline method, takes two hours, and, including preparatory work, four to six hours. A balloon once filled can work with occasional filling up, under favourable conditions of weather, for seven days.

(ii.). He must select a suitable officer to carry out the reconnaissance, being guided in his choice by the capabilities of the officer, his nervous temperament, keenness of vision, ability for transmitting what he sees to paper, etc. In case of prolonged observation, or in case of accident, he must detail a roster of officers to relieve the observer when necessary.

(iii.). He also details an officer, who should not be the one chosen first for observing, to superintend the generation of gas.

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(iv.). He must decide on the place of ascent. In this he must be guided by the desirability of having the sun behind the observer during the period of his reconnaissance, and the place must also be accessible for the balloon and winch wagon, and convenient for free management of the balloon ascent.

(v.). He must select the road of approach, which should, if possible, be screened from the enemy's view. At the place of ascent the winch wagon should be concealed from the enemy.

(vi.). And, lastly, he must himself superintend closely the whole progress of the work.

The tasks allotted for reconnaissance may vary in character, as follows:—

(1). When a definite object is detailed for observation. As, for example, "How the enemy is posted in village A," or "The actual position of certain batteries," or "To make a sketch of village C," or "To determine whether the enemy has stores, reserve forage, fuel, etc., in village C."

Or (2) when a definite point of observation is not detailed. As "To decide on the positions of the enemy along the whole front of a position."

In these cases the place for ascent can be chosen chiefly for its convenience for observing, and constant conversation on the telephone should not be allowed to distract the attention of the observer. The results of the observing can generally be kept back, to be included in one general report at the end of the day's work, except when anything of extreme importance (such as the movement of the enemy to a new position or the pitching of a camp within range of shrapnel fire) is noticed. The report should be accompanied by sketches or pencil tracings of the map, on which the results of the reconnaissance are shown in ink or coloured pencil. Local objects, which might serve as landmarks to troops making use of the reconnaissance, should be marked on this map.

The report, when finished, is sent to the Chief of Staff of the force, and a receipt for it should be given on the envelope and returned to the company. This is attached to the office copy of the report and sketches, and carefully preserved in the company records.

(3). The third kind of reconnaissance, varying greatly from the other two in the method of reporting results, is when the balloonists are ordered to carry out a continuous observation of the movements of the enemy, either generally, or over a specified area only. In this case, besides convenience of observing, the place of ascent must be convenient for passing on the information received, and consequently its selection must be shared by the Chief of Staff. The communication between the balloon and earth is carried on by telephone, and the reports may be sent on either by telephone or by mounted orderlies.

There should, if possible, be two observers in the balloon, and of these one should be an officer especially suited to the allotted task, and belonging either to the general staff, engineers, artillery, or topographical corps. The officer chosen should have had some previous experience in balloon ascents, as otherwise little useful observation could be expected of him, and he would find difficulty in comparing the ground with the map.

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Two more officers, or trained non-commissioned officers, are required below. The method of working is as follows:—No. 1, in the balloon, observes, while No. 2, with the telephone transmitter attached to his head, follows the observations on a map, and passes them on down the telephone. No. 3, below, is similarly equipped with map and telephone transmitter, and he repeats aloud, following it on the map, the information sent by No. 2, giving that officer the opportunity of correcting any mistake or inaccuracy, and No. 4 notes it down in a field book.

Except in special cases (as when artillery is seen to be moving into position or a column advancing to the attack) these reports should only be sent down at the end of each quarter of an hour, and they are collected by the company commander, and, except in especially urgent cases, are sent on to the Chief of Staff at the end of each hour.

At the end of the day's observing a general report is sent in of the results of the work, and any sketches which No. 1 may make are forwarded either with this, or with one of the hourly reports.

On the envelopes containing these reports the words "From balloon" are written, in the place in which the degree of urgency is usually noted.

(4). The fourth, and most responsible and difficult of all the classes of reconnaissance, is that carried on during a battle. This is essentially very similar to the third kind, but all reports must be sent forward without delay. In case of the discovery from the balloon of a turning movement or concealed approach of the enemy against some point in the position, the company commander must first send a special report of it, by a trustworthy messenger, to the officer commanding at the threatened point, marked "Very urgent, from balloon." He next reports it to the Chief of Staff, adding the information that the news has been sent to the threatened point, and that he is about to send a duplicate, in case of the loss of the original message. This duplicate is sent forthwith by another orderly, and as far as possible the progress of the orderlies is watched from the balloon, so that if both fail, a third may be despatched. In this case the return of the receipted envelope is a matter of extreme importance.

Correcting the Fire of Artillery.

For this work the company is placed at the disposal of an artillery commanding officer, and with him the company commander selects the place of ascent. In this they must be guided both by the convenience of observing, and also of promptly reporting the results to the battery. About a mile in rear, and 600 yards to a flank of the battery, is the most suitable position.

It is necessary for accurate observing that the battery should fire either one gun at a time, or by section or whole battery salvos, in the latter cases all the guns being given the same elevation. They should then wait until the correction is completed before they fire again.

In this observing the results are sent by telephone by No. 4 to the battery. When about to fire, the battery commander sends information to the balloon of the number of guns and the nature of the shell (as "One with shrapnel" or "Section with melinite," etc.), and then sends

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the word "Fire," as otherwise the observer may not be on the alert and may fail to notice the strike of the shell, from which only any result can be obtained.

The observer sends down the result of the observation, such as "Short 40 *sazhens*, to right 100 *sazhens*," or "Hit, fire seen in village," etc., etc.

In the absence of telephones the results can be conveyed by pre-arranged signals hung from the balloon.

When artillery fire is being observed from a balloon, it is natural that no other batteries must fire at the same target.

The greater the height of the balloon ascent, the better generally are the results of observing artillery fire.

When there is a good plan of the target, it is useful to divide it into 1-inch or ½-inch squares, and to number them. These plans are then supplied to the balloon and to the battery, and the corrections are shown by squares. This method was used during the bombardment of Sandepu on January 28th, 1905.

SIGNALLING.

Signalling from balloons is carried out when other means of passing information appear to be impossible or exceedingly difficult, and also for the simultaneous distribution of orders and directions to several bodies of troops, which may be at some distance apart. It is carried out by day by means of combinations of frames, in the forms of balls and cylinders (which are visible to the naked eye up to 4½ to 5 miles, and with Zeiss field glasses up to 10 miles), and by night by means of lights.

Signalling may be done in two ways; the first of which is when it is required to carry on conversation between two points, both of which are supplied with signalling aerostats. In this case one station calls up the other with a special signal, and keeps it up until the other repeats it, after which it is taken down. The message is then sent in the same way, no signal being taken down until it has been repeated correctly by the receiving station. If the answering signal shows that the original signal has been read incorrectly, the sending station either leaves its signal up or hauls it down, and after a short pause sends it up again, to call the attention of the receiving station to its erratic reading of the signal. A special sign shows the end of the message.

The second form of signalling is when a single aerostat is used for sending a message which requires simultaneous action in several places. In this case the meaning of the signal may possibly not be divulged even to the company commander; but it is most important that he should get his orders in writing, and that they should specify exactly the form of the signal, at what time it should be hoisted, and for how long. When a signal is hoisted the fact must be reported to the Chief of Staff of the force.

Night signals can be used as marks for orienting special lines and for conversation by the Morse code.

F. E. G. SKEY.

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REVIEW.

BEHELFSBRÜCKEN-VORSCHRIFT. 1907.

THIS is the German handbook of temporary bridges, and contains all the instructions issued on the subject except those for pontooning, which are dealt with in a separate manual.

Like all German regulation books, it is small, compact, and exhaustive; this volume has 139 pages, about $6'' \times 4\frac{1}{2}''$.

The principal contents are:—

I. Reconnaissance and choice of bridge sites.
II. Collection and testing of available *matériel.*
III. Preliminary considerations, such as measures against drifting obstacles, wind, flood water, and ice; proper distribution of working parties; sufficient supply and reserve of *matériel*, etc.
IV. The various kinds of bridges.
V. Heavy, medium, and light bridges, in which pile, trestle, lock, boat, cask, and raft bridges are described.
VI. Testing, strengthening, and repair of bridges.
VII. Protection and guarding of bridges.
VIII. Ferrying and transport of troops over water with extemporized *matériel.*
IX. Heavy and railway bridges on the lines of communication.

There are some very useful appendices printed on coloured paper—with a view no doubt to their being easily found—giving separately for heavy bridges, and heavy line-of-communication bridges, the size of timber rails and girders required for various spans from 1 to 8 mètres, with 5 or 7 baulks, 2, 3, and 4-legged trestles, etc., so that the exact material required for a particular span can be seen at a glance. There is nothing new or novel in the diagrams, or in the methods proposed; the value of the book lies in its compact form.

'E.'

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NOTICES OF MAGAZINES.

Revista de Engenheria Militar.

October, 1907.

Concerning the Creation of the Supreme Council of National Defence (*concluded from the September number*).—The author continues the discussion of the advantages and disadvantages of alliance with Great Britain, and the effect on Portugal of the *entente cordiale*, the Anglo-Japanese alliance, and the meetings of King Edward with King Alfonso at Cartagena, and with King Victor Emmanuel at Gaeta. He also points out the value, to Great Britain, of a friendly Portugal, in the event of a maritime war between the former country and Germany. He presses for the conclusion of a military convention between England and Portugal, and for the defence of the Bay of Lagos.

Some Considerations concerning the Field Balloon Park belonging to the Ministry of Marine (*concluded*).—The author continues his description of the material, and concludes by making certain proposals for its improvement.

Some Extracts from the Report of the Engineer, Rego Lima, on his Mission to the Mines of Cassinga, 1898 (*continued*).—The article continues the detailed geological description of the Bundambungo district.

Coast Defence.—A transcript of the transcript which appeared in the *R.E. Journal* of the article by Major Mielichhofer in the *Mitteilungen über Gegenstände des Artillerie-und Geniewesens.* It is interesting to note that the *R.E. Journal* is studied in Portugal, and that an English translation is preferred to a German original.

November, 1907..

The Military Operations in the South of Angola.—The military operations, which have been in progress for the purpose of reducing to obedience the inhabitants of the Cuamatas district, have been brought to a successful conclusion by the capture on the 24th September of Little Cumato, and on the 6th October of Grand Cumato, after a difficult and trying march, during which the natives offered a vigorous resistance. The executive of the *Revista* offers its congratulations to the troops who took part in the operations.

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PRACTICAL INSTRUCTION IN MILITARY ENGINEERING AT THE ARMY SCHOOL.—By Capt. João d'Oliveira.—It is the object of the author to compare the present state of instruction, at the Army School, with what it was when he was a cadet there in the years 1889–92. His recollection, of the courses of instruction, is that they were of but little practical value in fitting him for the position of an engineer officer, and from a close study of the existing programme of studies, he comes to the conclusion that there has been but little improvement during the last 15 years.

NEW INSTALLATIONS OF THE INSTITUTE OF THE INFANTE D. AFFONSO.—This institute is intended for the education of the daughters of military and naval officers. This paper gives details concerning the building, its drainage, and hot and cold-water systems.

JAPAN AND THE UNITED STATES. THEIR NAVAL POWER.—A transcript of an article by Admiral Touchard, of the French Navy, which appeared in the *Correspondant*. It considers the relative naval power of the two nations, and the probable course of events should war break out between them. It was written before orders were issued for the despatch of the United States fleet to the Pacific, so is not quite up to date. The author considers that the first blow struck by the Japanese would be against the Philippines, that a force of 50,000 men might be landed at Cavite, Manilla taken in reverse, and Guam captured by the fleet. Hawai would next be taken, and perhaps used as a base against San Francisco, if the United States fleet had not arrived to protect it. Sea power will be the deciding factor. If the United States fleet is in the Pacific, and it Honolulu, Guam, and Cavite are fortified, the task of the Japanese becomes much more difficult. A Japanese army could not be landed in the Philippines until any American naval force that might be in those waters had been beaten.

'M.'

REVUE DU GÉNIE MILITAIRE.

November, 1907.

THE INFLUENCE OF THE SIEGE OF PORT ARTHUR ON THE CONSTRUCTION OF FORTS.—*A continuation of the previous article.*—As long as the hills Ouglovaia and Takushan were in the hands of the Russians, they commanded Taho Bay, Pigeon Bay, and the plain lying between the latter and the west front. Until Ouglovaia was captured it was impossible for the Japanese to attack from the west. By the capture of Takushan and Siaokushan, however, they were enabled to attack from the north-east. On Takushan the Japanese constructed an observatory, from which they could observe their artillery fire and direct their assaulting columns. It

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is clear, therefore, that if the Russians had fortified Takushan in any adequate manner, they could have held it much longer, and so postponed the development of the Japanese attack. Had the fortifications of Port Arthur been finished before the outbreak of war, the Russians could have devoted some labour to Wolf Hill, and have constructed an advanced position here. Wolf Hill commanded the principal roads to Port Arthur, and also the valley in which the Japanese formed their siege depôts. As long as Wolf Hill was held, the Japanese would have been unable to bring up their siege material. These various instances illustrate the important part that advanced positions may play.

During the cannonade, which preceded the Japanese assaults, the Russian guns were completely silenced. This was due to their exposed positions and the absence of shields. In addition, the want of head and overhead cover rendered it impossible for the garrisons to man the parapets of the works, and they were compelled to take refuge in underground shelters. Some of the works were even unable to maintain a look-out. Owing to this, one of the Panlong redoubts was captured by the Japanese, without the Russians in the next work, only 350 yards away, discovering the fact. Under these circumstances it was, of course, impossible for the works to support each other. It is clear that in future every work must be provided with armoured look-out stations and bombproof caponiers, from which infantry and machine-gun fire may be brought, even during the heaviest bombardment, to bear on the intervals between the works. At Ehrlong some caponiers were improvised at the ends of the gorge to flank the intervals. It is estimated that the fire from these caused more than 3,000 casualties among the Japanese.

In future the distance between works should be limited, not by the range of the rifle, but by the range of the search light. The maximum interval appears to be about 1,100 yards.

The Chinese wall, although a relatively feeble obstacle, played a great part in checking the Japanese assaults. They were only able to pass it at points where it had been virtually destroyed. It therefore seems desirable to close the intervals between the permanent works with a deep, permanent ditch and a musketry parapet—the ditch to be flanked by caponiers at each end. This ditch would also protect the batteries situated behind the intervals between the forts, and thus do away with the necessity of providing an infantry garrison for each battery.

It is a mistake to construct temporary works—as distinct from advanced positions—outside the line of permanent fortifications. The enemy's attack should be awaited on the line of the permanent forts, which will be presumably the strongest line of defence. Temporary works should be constructed inside the line of permanent forts, to check the enemy if he succeeds in penetrating the main line.

The need of bombproof shelters, for the infantry in the intervals between the forts, was much felt during the siege. The number of shelters required appears to be: (1) two to hold a half-company each for the garrison of each interval, and (2) one to hold a company for the supports. In addition, shelters must be provided for the reserve of each section.

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It is most important that the interior of the fortress should be well screened from view. This can be best done by planting trees.

December, 1907.

It is now generally recognized that all batteries must be hidden, and must use indirect fire only. It does not seem necessary to use concrete in the construction of batteries; earthen parapets and traverses stand shell fire almost as well and are more easily repaired, besides being far less expensive. A number of alternative earthen batteries should, therefore, be constructed, a few concrete bombproof casemates being provided near them, to shelter the gun detachments when necessary.

The Russian batteries, which were situated in the main line of defence, were all captured during the early stages of the siege. It is, therefore, clear that the batteries should be placed some distance behind the line of principal works, so that the enemy must pierce the latter before he can assault the batteries.

It seems desirable to mount only two guns in each battery, so as to reduce the enemy's target as much as possible. The batteries should be arranged in several lines; field guns nearest the enemy, then howitzers, and lastly long range, heavy guns. The batteries should be organized in groups of five or six, with an observatory for each group. Guns that are required to repel an assault should be kept under cover till the last moment.

Ammunition sufficient for three days should be stored in the battery magazines. An intermediate magazine, placed some 300 yards in rear of the group of batteries, should contain a five days supply of ammunition. This magazine should be replenished directly from the main magazine of the fortress.

Every fortress should be provided with a railway, which should be laid and kept in working order in peace time. It will then be available on mobilization for the transport of stores and material. This railway should run behind the batteries, and ample spare material should be provided, so that it may be extended to any fort, battery, or magazine as may be required. The railway must be carefully concealed from the enemy. As steam locomotives betray their presence by smoke and noise, some other means of traction seems desirable. In addition to the railway, there should be a network of good roads connecting all parts of the fortress, and silent mechanical transport should be provided for use on these.

Search lights will be indispensable in future. The *rôle* of fortress search lights will be to discover any massing of the investing troops, to hamper sapping, to reveal the approach of assaulting columns, and to ward off the beams of the enemy's search lights. The following search lights will be required:—One large light in each fort or intermediate work, two smaller lights in the gorge caponiers of each work to flank the intervals, and two small lights in each interval to light the ground in the immediate vicinity. The latter should be mobile lights, fitted with

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dynamos and engines, so as to be quite independent. The search lights should be controlled by the artillery, so that lights and guns may work together.

There should be two telephone systems in a fortress; the first to be devoted entirely to the artillery, and the second to connect the infantry works with each other, and with the general staff. Only underground cables should be used, and these should be laid in wooden channels. In the zone exposed to direct artillery fire the cables must be laid deep enough to escape damage by the heaviest shells. Elsewhere, the depth need not be so great. Each work should be connected to the general staff by two alternative routes.

Wireless telegraphy should be utilized to connect the fortress with (1) towns or fortresses in its vicinity, (2) with advanced positions and outlying forts, and (3)—in the case of coast fortresses—with the fleet.

The garrison of Port Arthur was originally fixed at 11,300, or 760 men per kilomètre. It actually amounted to 41,016 at the beginning of the siege, and of these 34,503 were effective. The garrison was distributed as follows:—Coast batteries, $1\frac{3}{4}$ battalions; first line, including advanced positions, $25\frac{1}{4}$ battalions; general reserve, $7\frac{1}{4}$ battalions; garrison of the citadel, 13 battalions of militia, and one company. It will be noticed that the general reserve amounted to only one-sixth of the total force. Shortly after the Japanese commenced their attacks the general reserve had dwindled to two battalions. By November the companies had been reduced to between 60 and 70 effectives. The infantry were divided into three reliefs. The first relief was on duty in the works, the second relief was employed on repairing the damages caused by the enemy's fire, and the third relief slept, one-half being fully equipped. The infantry, therefore, only got one night's sleep in three. This so severely affected their health that at the end of the siege there were only 5,000 men really fit for duty, 12,000 only nominally effective, and 26,000 sick.

Judging by the experience of Port Arthur, the author calculates that a fortress, with a circumference of 56 kilomètres, will require a garrison of 129,000 infantry, allotted as follows:—

23 forts at 400 each, and 23 intermediate redoubts at 200 each	14,000
Garrison of the front attacked (two intervals) ...	5,000
Remaining intervals	20,800
Local reserves	12,900
General reserve	76,300

These numbers will allow of one night's sleep in two. After five months siege the number of effectives will be reduced by a half, and the general reserve will then amount to 11,800 only. The writer calculates that 10 fortress companies, four railway companies, a telegraph battalion, and three balloon sections would be required for this fortress.—*The article will be continued.*

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EMPLOYMENT OF TRACING PAPER FOR GRAPHIC SOLUTIONS.—A short description of a method of solving geometrical problems by the help of a sheet of tracing paper, on which are drawn the variable elements in the problem. This is laid over a sheet of ordinary paper, on which the constant elements have been laid down. The tracing paper can be given a movement of translation, or rotation, or a combination of both. The following is a specimen of the problems which can be solved in this manner:—

A right angle ABC moves in such a manner that the line BA passes through a fixed point on the axis OX. The apex B moves at the same time along OY. The length BC is constant $= l$. Find the intersection of the curve traced by the point C with a given straight line, which is parallel to OX, and distant b units from it. The equation to be solved is then $b^2(l^2 - x^2) = (ax - x^2 + l^2)^2$. By the aid of the tracing paper the graphic solution of this formidable equation is made easy.

J. E. E. CRASTER.

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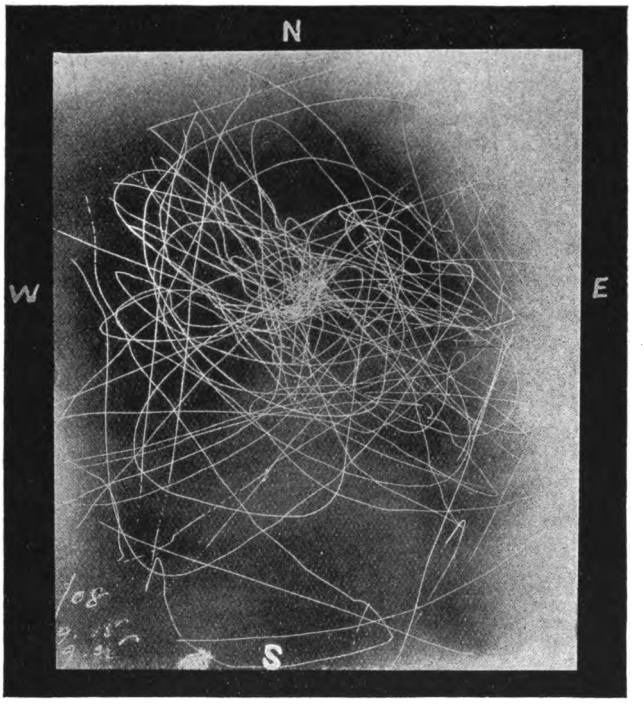
CORRESPONDENCE.

EARTHQUAKE AT JAMAICA, 2ND JANUARY, 1908.

SIR,

I enclose you a seismographic record of an earthquake which occurred here on 2nd January last, in case you may consider it of sufficient general interest to publish in the *R.E. Journal*.



KINGSTON EARTHQUAKE, JANUARY 2ND, 1908.
SEISMOGRAPH RECORD.
Time—8 hrs. 9 mins. a.m. Duration—20 seconds.
Max. Horizontal Movement—0·314 inch.
Magnified 12 times.

This earthquake is described, amongst others, in the following cutting from the Jamaica *Daily Gleaner* of 7th January last :—

> "This rather large series of local shocks was followed by the severe shock of January 2nd. It occurred at Kingston at 8 hrs. 9 mins. 15 secs., and its intensity all over the island was about the same, and between Nos. III. and IV. of the earthquake scale.

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"At Kingston its duration was 20 seconds; the general direction was from S.E. to N.W., and the movement was 0·314. But this recorded movement included both the elastic waves of the seismologists and the undulations of the ground to which I have frequently called attention.

"At Chapelton there were tremors for 3½ seconds, then there was a pause for 1½ seconds, then tremors again for 5 seconds, and finally undulations for 5 seconds, making altogether 15 seconds. There was no doubt about the undulations, they could be seen as well as felt, and the water in a large iron tank was dashed from side to side."

The earthquake did practically no damage in Up Park Camp, as the buildings there are now built so as to resist earthquakes, but it caused a good deal of damage in other parts of the island.

The disastrous earthquake of 2nd January, 1907, was of an intensity of VI. on the earthquake scale, but as any recording instruments then existing were wrecked, no seismographic records of it were obtained.

The ruin produced by that earthquake, and the small amount of restoration that has so far been effected, must strike anyone coming here for the first time almost in the nature of a shock, and an interesting report of the extraordinary freaks and vagaries of earthquakes, might be written.

Probably, however, none but those who come into close contact with earthquakes take much interest in them.

I am indebted to Mr. J. F. Brennan, of the Public Works Department, Kingston, for this interesting record.

W. R. STEWART,
Bt.-Col., R.E.

The Editor, *R.E. Journal.*

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RECENT PUBLICATIONS OF MILITARY INTEREST.

JANUARY, 1908.

(*Published Quarterly*).

THE following extracts from the list compiled by the General Staff, War Office, are published in the *R.E. Journal* by permission of the Army Council.

HISTORICAL.

EIGHTEEN MONTHS WITH RUSSIA'S ARMIES IN MANCHURIA. VOL. II. (Achtzehn Monate mit Russlands Heeren in der Mandschurei). By Major Freiherr von Tettau. 483 pp. Seven maps and numerous photographs. 8vo. Berlin, 1907. Mittler. 8s. 6d. (For Vol. I. see page 8 of No. 1).

This volume continues the narrative from the close of the Battle of Liao-yang to the end of the war; it is fully equal in dramatic interest and military value to its predecessor. Major von Tettau continued to be attached to the 10th Army Corps until it was broken up during the Battle of Mukden, but he is able to give an excellent account of the action of the other corps from Russian sources, so that the volume is practically an account of the Battles of the Sha Ho, Hei-kou-tai, and Mukden from the Russian side. It is very rare that such a clear narrative is obtained from the unsuccessful side so soon after the events; the book might very truly have been entitled "The Causes of Russian Defeat"; it is worthy of the closest study.

A good deal of light is thrown on General Mishchenko's raid; the orders for it are given *in extenso*. The intention is thus stated:—"I have decided to attack the station Ying-kou (where there are great magazines), and to destroy it completely." The raid was carried out at a walk. One charge only was made—against some infantry firing from behind a wall. The greatest care appears to have been taken to keep well away from Japanese troops and their line of communication, the Dalny-Liao-yang railway. Yet among the younger cavalry officers, at any rate, General Mishchenko, though an artilleryman, was considered to be the best cavalry leader in the Russian Army, and there seems to have been considerable difficulty in replacing him, for during the 41 days that he was on the sick list, wounded, no less than 11 senior cavalry officers were tried as a substitute for him.

The geographical objective seems to have been the favourite one with the Russians; as the author says, "the objective of the attack was not the annihilation of the enemy, but the conquest of a piece

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of ground . . . which had no significance in relation to a decisive victory"; "the objective was not to defeat the enemy, or even to separate him from the rest of the army, but it was to drive him behind the old railway dam."

Taking no risks was characteristic of all the Russian operations. General Kuropatkin had a number of fortress guns brought down to the Sha Ho lines by field railway. "Towards the end of February, when the decisive moment approached, the thought uppermost in everyone's mind was to get the guns away in safety as soon as possible." Careful arrangements were made, not only to guard the flanks, but the rear; but the flank detachments (*e.g.*, Dembovski's at the Battle of the Sha Ho, which actually overlapped the Japanese left flank) remained in "positions," and would not take decisive action.

The attacks were always of the "progressive" nature; at the Sha Ho, Lieut.-General Stakelberg's army (Kuropatkin's "direction" to him is numbered 10,053 (!)) was to begin the battle and obtain a decisive result on the Japanese right flank; when this was attained the other armies were to attack. The Battle of Hei-kou-tai affords another example. General Kuropatkin's "direction" was to the effect that the "2nd Army should begin the attack alone, and gradually capture the fortifications of the Japanese left wing. The attack of the other armies, which were to hinder the enemy from sending reinforcements to his left wing by demonstrations, was to be dependent on the progress of the attack of the 2nd Army." The tactical ideas of the commander of the 2nd Army were quite in accord with those of the Commander-in-Chief, and he, also, sent his troops into action progressively, with the result that hard fighting was only done by the 1st Siberian Army Corps, whose commander (Lieut.-General Stakelberg) "possessed initiative and enjoyed responsibility" (*Verantwortungs-freudigkeit*); thus it happened that only one of the three armies, and only one-third of that army, was engaged, while more than eight-ninths of the Russian forces looked on. Lieut.-General Stakelberg lost 6,891 men, 29 per cent. of the strength of his corps; he was removed from his command and sent back to Russia. He and his corps had been brought from the extreme left of the Russian line to the extreme right, for the special purpose of making a decisive attack.

During the progress of this puzzling battle the Russians took a "rest day."

At Mukden, on the 6th March, there is the same strange picture: "An army of 370 battalions is to attack; the attack is entrusted to the Right Army of 130 battalions. This army again orders its Right Detachment, 40 battalions, to begin the attack. This detachment directs its Right Column to take a village held by the enemy, and two regiments are sent to attack it; as they do not make progress, the whole army waits and abandons the attack."

There was frequent interference from the higher leaders in the province of subordinates. The commander of the 10th Army Corps

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constantly received direct orders by messenger and telephone from General Kuropatkin, which were at variance with those issued to him by the commander of the 2nd Army, to which the 10th Army Corps belonged. Yet when direction was necessary, as, for instance, when the 6th Siberian Army Corps looked on at the defeat of the 17th Army Corps at the Sha Ho, no instructions were sent.

During the most critical moment of the Battle of Hei-kou-tai, Lieut.-General Stakelberg was called on by an "urgent" letter to render statistics as to his strength and equipment, and expenditure of ammunition, to report minutely on his general staff officers, to make recommendations for St. George's Crosses, and give other particulars beloved of bureaucrats. He might as reasonably have been asked to send in a travelling claim (in duplicate) for his march from the eastern to the western flank of the army. His corps, it may be mentioned here, was sent to the left flank during the Battle of Mukden, and then marched back to the centre.

The initiative was invariably left to the Japanese. Orders for the offensive, however, were frequently issued overnight "for to-morrow," but as the Italian attaché pointed out, "to-morrow" (*zavtra*) in Russian really means "never." The orders were generally followed by counter-orders:—"The attack ordered will not take place."

The muddle and intermixture of units at the Battle of Mukden seems almost incredible. General Kuropatkin's reserve on the 19th February consisted of (1) the 16th Army Corps (less one brigade), (2) the 72nd Division (with the 10th Artillery Brigade), and (3) the 146th Infantry Regiment. On the 25th February he sent the 146th Infantry Regiment and one brigade of the 72nd Division to the left; on the 26th half the 41st Division (of the 16th Army Corps) to the right, and the remainder of the 72nd Division to the centre. This left him only the 25th Division (of the 16th Army Corps), which he sent to the right on the 1st March. He meantime endeavoured to collect another reserve, asking for an army corps from each Army; as the Armies were all heavily engaged they could not comply, but sent driblets—a division, a brigade, even battalions. The troops which were thus collected to repulse the attacks of General Nogi's Army were rapidly grouped together in "detachments"; not a single higher unit of the *Army List* appears to have fought on the west of Mukden. The "North Detachment," on the 10th March, consisted of 51 battalions, 21½ squadrons, and 132 guns, drawn from 11 different army corps, 16 divisions, and 43 infantry regiments.

It is of interest to read that in one of the few successful Russian operations, the counter-attack on Yu-hung-tun at the Battle of Mukden, "the Russians abandoned their massive formations, and the Kozlov Regiment, which passed close by the place where I was standing, was formed in eight or nine long thin lines, which followed one another at about 80 or 90 paces distance, with from four to five paces between individual men."

In a final chapter Major von Tettau sums up his experiences and the lessons of the war. With every justification he says: "These

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lessons are not novelties; they merely confirm what we (Germans) have long recognized as the basic truths of training and leading troops. For us, therefore, the lesson is to hold fast to these truths, and to educate ourselves to be leaders who love initiative and do not shirk responsibility, and, by iron discipline and all available energy, to educate our soldiers to be patriotic, and self-thinking and self-acting warriors."

REPORTS OF MILITARY OBSERVERS ATTACHED TO THE ARMIES IN MANCHURIA DURING THE RUSSO-JAPANESE WAR. Part V. General Staff (U.S.A.). 216 pp. 28 photos. 8vo. Government Printing Office, Washington, 1907.

This volume contains reports on the organization, administration, and tactics of the two armies. The account of the Japanese Army, which takes up three-quarters of the volume, is the fullest and most complete that has been made public. Lieut.-Colonel McClernand, the writer of it, comments specially on the fact that the affairs of the Japanese Army are conducted "with much less writing than with us." "In the offices of the Chief of Staff, Minister of War, and their assistants I was particularly impressed by the absence of the numerous bundles of papers so conspicuous in our department"; and he attributes this great economy of time and energy to the "total absence of non-military persons" in these offices.

It was stated positively to him that "no written records are required in a company except one book called *chutai meibo*, translated 'a company roll,' in which is entered the names of men on joining and leaving the company, the names of all killed and wounded, and of those sent home or to hospital, etc.

"At battalion and higher headquarters a book called *jinchunissishi* (daily record of campaign) was kept. In this was entered everything of importance . . ."

Ration returns were submitted daily; there was a prescribed form, but usually a slip of paper, on which was entered the mere number of rations required, was used.

Returns of strength were made every 10 days, in battle daily, if possible. "Company returns are consolidated at battalion headquarters, and then forwarded to the headquarters of the regiment, where similar consolidation is made; and so on, up to army headquarters."

The men are paid every 10 days by a selected non-commissioned officer, who receives the money from the battalion paymaster. A note of the payment is made in each man's small-book by the use of a stamp. Stoppages are rare; they are refunded in cash to the paymaster.

Routine correspondence with regard to administration was carried out direct between the divisional headquarters and Japan and the line of communications, and did not pass through army headquarters.

The photographs exhibit the equipment and transport of the various arms of the service.

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HUMAN BULLETS: A SOLDIER'S STORY OF PORT ARTHUR. By Tadayoshi Sakurai, Lieutenant, Imperial Japanese Army. Translated by Masujiro Honda, and edited by Alice M. Bacon. 270 pp. 8vo. London, 1907. Constable. 5s.

This is the account of the author's experiences from the day of mobilization until he was severely wounded in legs and arms on the 24th August, 1904, at the first general assault on Port Arthur. The author's regiment, much to its disappointment, missed the Battle of Nan Shan, but took part in the Battles of Wai-tou-Shan and Chien-Shan, in the taking of the hill of Ta-po-Shan on 26th and 27th July, in the attack and capture of Ta-ku-Shan on 7th and 8th August, and eventually in the first general assault of Port Arthur. The book is purely the story of the author's own experiences, first as a standard bearer of the regiment, and later as lieutenant in the 12th Company of the 3rd Battalion of the same regiment, and though it deals with no questions of strategy and barely touches upon tactics, it is of the greatest interest as a human record. The story is told in a simple, unaffected style, and gives a vivid picture of the desperate struggles of the Japanese in their assaults on the Russian positions.

Perhaps the most remarkable feature of the book is the spirit of intense patriotism and devotion to the Emperor which runs through it, and which, according to the author, was intensified by the Imperial Rescript (given in Appendix B) to the Army and Navy at the beginning of the war. Much has lately been written about the spirit of Bushido, but this simple recital brings it vividly home to the reader. The determination of the troops to die for the Emperor and to avenge their dead comrades; the feeling approaching to shame which animated the author when he emerged unscathed from engagements in which many of his comrades had been killed and wounded; the spirit which impelled each Japanese officer or soldier to help the common cause and one another—all show what enabled the Japanese to effect what they did in Manchuria. The spirit mentioned above is exemplified in this book by many incidents, which are recited in such a way as should inspire others with a desire to emulate those deeds.

THE END OF THE SIEGE OF PORT ARTHUR. An epilogue to *The Truth about Port Arthur*, Parts I. and II. By E. K. Nojin. 487 pp., with illustrations. 8vo. St. Petersburg, 1907. "Herold," 3 Voznesenski Prospekt. 6s. 10d.

This sequel to *The Truth about Port Arthur*, which was produced last year by the same author in two volumes, has been written with the apparent object of extolling the spirit of heroic devotion which inspired the junior ranks of the defenders, and, at the same time, of assisting in bringing home to the responsible commanders the charge of surrendering the fortress without justifiable cause.

The arrangement of the subject is wanting in continuity, and the book suffers from a total absence of any index or table of contents.

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The greater part of the material consists of copies of orders and extracts from the letters and diaries of various subordinate officers, the purport of which it is often difficult to discover.

The proceedings of the last conference, held by General Stössel previous to the negotiations for the surrender, are given apparently *verbatim.*

Statistics are introduced showing the state of the armament, the sanitary condition of the troops, and the supply of provisions in the fortress during the siege.

In conclusion, the author quotes the charges preferred against Generals Stössel, Reis, Fok, and Smirnov. The value of the work for historical or tactical purposes is small.

WELLINGTON'S CAMPAIGNS, Peninsula—Waterloo, 1808–15 ; also Moore's *Campaign of Corunna.* (For military students). By Major-General C. W. Robinson, C.B. 722 pp., with maps and plans. 8vo. London, 1907. Rees. 8s. 6d.

In this volume the previous Parts I., II., and III. of *Wellington's Campaigns* are brought out together. It therefore forms a complete record of Wellington's campaigns from his landing in Portugal in 1808 till the conclusion of the Waterloo Campaign.

As the parts above mentioned have been before the public for some time it is unnecessary to enter here into details of the contents of this volume, and it will suffice to say that the texts, plans, and maps have been revised and a full index added. The book is written in a lucid style, and the maps and plans are clear and good. Though General Robinson does not enter deeply into details of the battles, yet many useful lessons of tactics, as well as of strategy, may be learnt from a study of this volume, and the saying of the late Colonel Henderson, quoted on page 672, should not be forgotten:—"In my humble opinion the campaigns of Wellington, not in strategy alone, but in tactics also, are prolific in instruction."

WATERLOO. By the late Capt. J. W. E. Donaldson, Royal Field Artillery, and Capt. A. F. Becke, late Royal Field Artillery. 79 pp., with maps. 8vo. London, 1907. Rees. 2s. 6d.

This is a re-publication of Chapter V. of *Military History applied to Modern Warfare,* by the same authors. The claim made is that the book "perhaps presents to the military reader how the campaign may be advantageously studied." It is clearly written, and may be of use to students of the campaign to supplement larger works.

MARSHAL TURENNE. By the author of *Kenelm Digby,* etc., with an introduction by Brigadier-General F. Lloyd, C.B., D.S.O. 395 pp., with a map. 8vo. London, 1907. Longmans, Green. 12s. 6d.

This book opens with a short account of Turenne's early life and of his first military experiences, which began at the age of 14.

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The next chapter deals with the campaign of 1640 in Italy, during which Turenne distinguished himself at the Battle of Casal, and in which, at the siege of Turin, occurred the extraordinary spectacle of Prince Thomas of Savoy besieging the French in the citadel while he himself was besieged by the French Army, and the last-named were again besieged, in their lines of circumvallation, by the Spaniards. In this chapter some of Turenne's maxims are given, many of which are still applicable.

The next campaign dealt with is that of 1644, in Alsace and the Black Forest, and in this is included the Battle of Freiburg, in which the chief command was held by Condé, under whom the French gained a somewhat doubtful victory over the Bavarians.

In 1645 Turenne was defeated by Mercy and the Bavarians at Marienthal, and afterwards the Battle of Nördlingen was fought, where Condé was again in chief command, and where Mercy was killed; the battle resulted in the retreat of the Bavarians, but the French incurred very heavy losses, and it was largely owing to Turenne that they were not defeated.

The account of the campaign of 1646 in Bavaria is interesting, for although it was bloodless, it displayed to the best advantage Turenne's strategical skill.

With the campaign of 1648, the Thirty Years' War came to a close, and Turenne's activities were transferred to France, where the wars of the Fronde soon after broke out. Turenne fought first against and then for the Court, after the fashion of those times, when everybody changed sides continually, and allies one day were desperate foes the next; thus Turenne was now opposed to Condé. The Battle of the Dunes, on 14th June, 1658, where Turenne defeated Condé and Don John of Austria, and where English troops fought on both sides, is well described.

The remainder of the book deals with the campaigns of 1672–3–4 and 5, against the Imperialists in Flanders, Holland, Westphalia, and Germany, and descriptions of the Battles of Salzheim, Enzheim, Turckheim, and Sasbach are given. At the last battle Turenne, at the age of 63, was killed.

The author is a great admirer of Turenne, and there seems no reason to doubt that besides being a great strategist and tactician, Turenne bore a character for uprightness, fairness, and lack of avarice, which was rare indeed in those days.

The book is well written, and Napoleon's comments on Turenne's operations form one of its most interesting features.

THE AMERICAN REVOLUTION. PART III. By the Right Hon. Sir George Otto Trevelyan, Bart. 530 pp. 3 maps. 8vo. London, 1907. Longmans, Green. 12s. 6d.

This third part carries the story from the beginning of 1777, when Washington, after his victory at Trenton, was wintering his exhausted troops at Morristown, to the summer of 1778, which saw Clinton's evacuation of Philadelphia and his retirement to New York.

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Although Sir George Trevelyan does not write as a military historian, and omits to give prominence to dates, numbers, and orders of battle, yet he presents an exceedingly clear and vivid account of the military events and of the conditions under which the British and Americans fought, ample enough for a preliminary study of the campaign. His work is particularly valuable, as the history of campaigns in which the British forces have been unsuccessful is difficult of access; official accounts of them have not been written, and in consequence their study has been neglected. Yet, Lexington and Bunker's Hill, which were dealt with in the first part, bear striking resemblances to Bronkhorst Spruit and Laing's Nek, and many incidents in the second Boer War have their prototypes in the War of Independence fought more than a century before.

Many of the comments made by the author are of distinct military importance. He states that the average value of the British infantry was much reduced, "according to the questionable fashion of that day, by withdrawing the light companies from ten or a dozen regiments," and forming them into special corps; and that while "the American Army never stopped long in any one place without fortifying it to the verge of impregnability," the British commander "objected on principle to fieldworks," and, as he said, "never favoured their construction at the head of line when in force, for fear of diminishing the self-reliance and the well-founded self-esteem of his soldiers."

For the British the year 1777 is a record of blunders and lost opportunities. Sir William Howe, the senior British military officer in America, during a copious correspondence with the War Office, "while he placed on record his conviction that a large number of additional troops was required in America, confined himself (knowing something of his Government) to asking for a reinforcement of 15,000 rank and file, which would raise his army to the indispensable minimum of five and thirty thousand effective men." He represented the danger of operating in the New England States, where the population was large and warlike, and proposed to take the initiative in Pennsylvania, where the local militia was of little account. He considered that the American Commander would be bound to risk a battle, in order to protect the Capital of the Confederacy, and "My opinion," said Howe, "has always been that the defeat of the rebel Regular Army was the surest road to peace." When that army was crushed, resistance in New York and New Jersey would collapse, and a majority of the colonists in these central States would probably accept the rule of the stronger; operations could subsequently be carried out, first southwards—in Virginia and the Carolines—and eventually in New England, for their conquest and subjugation. This was a reasonable and practicable scheme.

The Home Government, in reply, promised Sir William Howe 8,000 men, and "sent him 2,900, but never a bayonet or a sabre more."

As regards the plan of operations also, they had different views.

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Lord George Germaine, who controlled the military destinies of the Empire "from a desk in a public office 3,000 miles away," had been placed in this position of practical responsibility "because he could debate, and for no other reason in the world; but he esteemed himself highly as a military authority, although he had long ago (when he bore the name of Lord George Sackville) been dismissed with ignominy from military employment."

Now Germaine "had conceived the ambitious hope of compensating for deficiency in numbers by brilliant and novel strategy." His scheme "looked well on paper, and was cleverly contrived for use on one of those bewildering occasions when a Cabinet of civilian politicians is under the necessity of resolving itself into a council of war." Three columns—Howe's, from New York; Burgoyne's, from Canada; and Colonel St. Leger's, from the Mohawk Valley—were to converge from south, north, and west on Albany, driving the Americans before them, and were thus to occupy the course of the Hudson, and cut off the New England States from the rest of the colonies.

A combined movement on exterior lines before the days of telegraphs had little chance of success without precise and minute directions. "But, as a matter of fact, Sir William Howe (whose army was twice as large as the other two columns together) never received any definite orders at all." On the 26th March he did receive a copy of the instructions addressed to General Burgoyne, and was informed that the Secretary of State would communicate with him by next packet. "No such communication ever reached Howe," but on the 18th May "Germaine wrote to him at great length, acquiescing in an expedition to Philadelphia," and incidentally expressing a vague hope that it might be concluded in time to co-operate with Burgoyne. Howe very properly kept Burgoyne informed of his plans and movements from time to time, an action which his ambitious junior did not, apparently, reciprocate.

Colonel St. Leger's column was delayed *en route* to the rendezvous by having to undertake the siege of a fort which blocked the way, and was skilfully dispersed by a ruse of Benedict Arnold, while still many miles from the Hudson. Burgoyne, a political favourite, who had never had an independent command before, left Montreal early in June. After overcoming enormous physical difficulties, he succeeded in covering 200 miles, and nearly reached Albany; but his small column was hemmed in by the colonists, who swarmed to arms when its isolated position became known. On the 13th October he surrendered with 5,800 men, "of whom half were Germans"; the Americans had previously captured 1,800 prisoners, including wounded. The news of this disaster only reached London on the 2nd December.

Meantime, while Burgoyne was in vain looking for his assistance, Howe, making use of the command of the sea, as McLellan did 83 years after, had in July put his troops on board transports, had

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taken them round by sea and up Chesapeake Bay, and had landed them within 30 miles of Philadelphia. He might certainly have reached a point nearer the city, and had a shorter voyage, had he selected the Delaware River as his route. Having landed, he defeated Washington, at the Battle of Brandywine, and his lieutenant, Wayne, in a night attack at Paoli, and entered Philadelphia on the 26th September. He subsequently very successfully repulsed a night attack made by Washington at Germantown.

Six weeks before the end of the year, however, Sir William Howe, "finding the War Office deaf to his call for reinforcements," wrote home and begged to be relieved. Lord George Germaine "resolved not to let slip the unexpected chance of proclaiming to the world at large that the general, and not the minister, was to blame." He recalled Howe, and sent out Sir Henry Clinton from England to succeed him. Clinton soon found that Philadelphia was practically a beleaguered city, and dependent on the Delaware for the transport of food supplies. Washington had fixed his head-quarters 22 miles from the city at Valley Forge, far enough away to be secure from surprise, but near enough to take advantage of opportunities; while his flying columns swept the country of supplies.

The expedition to Saratoga had now brought about further unpleasant results, for on the 6th February, 1778, France concluded a treaty of alliance with the United States, and a fleet, under d'Estaing, was expected off the coast in the early summer.

Clinton determined to evacuate Philadelphia before he was hemmed in by sea; sending his sick and wounded by water, on the 18th June he set off with 17,000 men to march overland to New York; although pursued by Washington, with whom he declined a decisive action (an opportunity for which Howe had sought in vain) at Monmouth Court House, in spite of tropical heat and pestering guerillas, he was successful in reaching his goal, on the 1st July, with the loss of a few hundred men.

Such is the general outline of the story unfolded. While deep sympathy must be accorded to the British generals, who were left to carry out an impossible task, it must be given in an equal degree to Washington, who was hampered by the zeal of Congress that, in the course of 19 months, framed and promulgated four successive army systems; by the dislike of his countrymen to give more than a few weeks' military service and to leave their ordinary occupation; and still more by the intrigues of political generals, who used all their eloquence to secure his removal and that of his prominent officers, and actually went to the length of refusing to his army, when at Valley Forge, supplies of food and clothing that were available; yet, in spite of difficulties, he always managed, by unfailing courage and skilful generalship, to keep a formed body of men in the field as a nucleus of resistance.

The volume contains a vast amount of interesting detail gathered from the diaries and writings of combatants on both sides.

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NAPOLEON: A BIOGRAPHICAL STUDY. By Dr. Max Lenz. Translated from the German by F. Whyte. 382 pp., with illustrations and maps. 8vo. London, 1907. Hutchinson. 16s.

This book is a study, partly personal, but mainly political. It gives all the principal events of Napoleon's career from his early days, during the internal struggles in Corsica in 1791–2, to his death at St. Helena. The book is only of military interest in so far as it deals with one of the world's greatest generals, and with the political events which caused, or were caused by, Napoleon's campaigns, for none of the campaigns is dealt with in any but a cursory style, and no strategical or tactical questions are entered into. The political and diplomatic sides of Napoleon's career are more fully dealt with, and much interesting matter is brought out regarding the motives which inspired his diplomatic action at various times.

The author is evidently a sincere admirer of Napoleon, and the book is written in a clear and easy style, and appears to have been well translated.

A STUDY OF FIELD MARSHAL COUNT RADETZKY'S CAMPAIGN OF 1848 (Studie über den Feldzug des Feldmarschalls Grafen von Radetzky, 1848). Anonymous. 30 pp., with 6 sketch maps. 8vo. Vienna, 1907. Seidel. 2s. 6d.

A short critical study of the 82-year-old field marshal's campaign in Northern Italy, which culminated in the Battle of Custozza on the 23rd to 25th July, 1848, and the subsequent pursuit to Milan. The publication of this pamphlet is opportune, in view of the recent 50th anniversary of Count Radetzky's death.

SADOWA. A Study by General H. Bonnal. Translated by Lieut. C. F. Atkinson, 1st V.B. Royal Fusiliers. 255 pp., with maps. 8vo. London, 1907. Rees. 7s. 6d.

This is a translation of the work published by General Bonnal in 1900, and forms part of the series "L'Esprit de la Guerre Moderne."

To students of the campaign of 1866 it needs no recommendation, since they are probably already acquainted with the French version, but to those who have not yet studied that campaign, or who have not a sufficient knowledge of French to read the original, this translation should be of great value. The translation itself has been very well done; the book is well got up and printed in large type, and the maps, though in some respects not beyond reproach, are good and clear. The account of the campaign is excellent—clear, and easily followed, and the comments of the author on the various phases of the operations are instructive. The book is mainly strategical, and gives no description of the minor battles, but presents the general strategical situation every day, supplemented by a separate map showing the situation on the evening of each day, and thus the student is led up to the grand climax of Sadowa. The battle itself is described with great clearness, and is illustrated by

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six plans. Appendices contain a bibliography of the Sadowa campaign, notes on the series "L'Esprit de la Guerre Moderne," notes on terminology, on the organization of the two armies, and on lengths of columns. Mr. Atkinson has done the army a considerable service by his translation.

THE WAR OF 1870–71. OPERATIONS IN THE EAST. Prepared in the Historical Section of the General Staff. 110 pp., with 2 maps. 8vo. Paris, 1907. Chapelot. 2s. 8d.

This volume describes the operations on the Rhine and in the Vosges from the outbreak of war to the 2nd September.

HISTORY OF THE WAR OF 1870–1871. Vol. VI. By Pierre Lehautcourt. 788 pp., with 9 maps. 8vo. Paris, 1907. Berger-Levrault. 7s. 6d.

The 6th volume of this history takes up the story with the retreat after Wörth, on 7th August. It follows the fortunes of MacMahon's army in the retreat to Chalons, the fight at Beaumont, the move to Sedan; and ends with the capitulation on the 3rd September. The book contains little comment on the strategy and tactics of the campaign; it is simply a full record of the events as they occurred; but it brings out forcibly the disastrous effects produced by the indecision of the Commander, coupled with constant interference on the part of the Paris authorities.

GENERAL LEE: HIS CAMPAIGNS IN VIRGINIA, 1861–1865, WITH PERSONAL REMINISCENCES. By Walter H. Taylor, Adjutant-General of the Army of Northern Virginia, C.S.A. 314 pp. 9 maps and plans. 8vo. Norfolk, Virginia, 1906. Nisbaum Book Company. 10s.

In 1878 Colonel Taylor published his *Four Years with General Lee*. The chief interest of that work was statistical, the writer's object being to show that the odds against General Lee were greater than has been generally supposed. The earlier work being out of print, the author was persuaded to publish these memoirs, which were not originally intended for publication. They do not profess to give a critical account of the campaigns in Virginia, but rather aim at enabling the general reader to form a fair idea of each of the great battles fought. Their chief interest will probably be found to consist in the light which they throw upon General Lee's personal character. It cannot be said that they add much to our knowledge of the working of the Staff of the Army of Northern Virginia. The conclusion would seem to be that of all the different departments of an army, an efficient staff is the one least easily improvised. As in his first volume, the author criticizes severely the conduct of Longstreet during the Gettysburg campaign, and supports his opinion by quotations from a review of Longstreet's *From Manassas to Appomattox* in the *Journal of the Royal United Service Institution*, October, 1897.

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MILITARY MEMOIRS OF A CONFEDERATE. By E. P. Alexander, Brigadier-General, C.S.A., and Chief of Artillery, Longstreet's Corps. 620 pp. Map and plans. 8vo. New York, 1907. Scribner. 16s. 6d.

No one could be better qualified to write the story of the Army of Northern Virginia than General Alexander, who accompanied that army from its cradle to its grave. At the outbreak of the war he was a second lieutenant of Engineers, U.S.A. Commissioned a captain of Engineers in the Confederate Army, he was present at the first battle of Bull Run as signal officer on Beauregard's staff. A few days later he was appointed chief of ordnance of the Army of Northern Virginia. In November, 1862, he succeeded Colonel S. D. Lee in command of an Artillery battalion, which formed part of Longstreet's reserve Artillery. From Gettysburg onwards he was in command of the Artillery of Longstreet's Corps. When the Army of Northern Virginia was reorganized after Chancellorsville, the general Artillery reserve was broken up, and the Artillery was reorganized with a few batteries to each division and a reserve to each corps. It is claimed that this reorganization was the first of the kind ever adopted, and was subsequently copied by the chief European powers.

The author states his object to be "the criticism of each campaign, as one would criticize a game of chess, only to point out the good and the bad plays on each side and the moves which have influenced the result."

The acuteness of his criticism and the impartiality of his judgment render his work of great importance to the military student. The romances, which have too often passed for history, find no place in this narrative. The Battle of Seven Pines is depicted as it really took place. It is clearly shown that Longstreet misunderstood Johnston's instructions, but that the latter, feeling himself partly responsible, shielded his lieutenant by representing in his report the battle as if fought according to his original plan, and also induced his second-in-command, G. W. Smith, to change his report. "The whole history of this battle remains a monument of caution against verbal understandings." The author's account of Chancellorsville rejects the legends of Pleasanton and others, and follows Colonel Hamlin's version of Jackson's flank attack.

The description of the first Bull Run is admirably clear and the criticism luminous. McDowell's errors in the conduct of the actual battle consisted in making a succession of partial attacks in the first stage, and in continuing the frontal attack instead of trying to turn the Confederate flank on the Henry House Hill. The Confederate commanders are blamed for not going "in person to supervise and urge forward the execution of the orders, though time was of the very essence."

The causes of Jackson's repeated failure during the Peninsular campaign are carefully examined, and his conduct from the beginning to the end of that campaign severely criticized. It is pointed out

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that he was a day late to begin with, partly because of his passion for Sunday observance, partly because he failed to make up for his loss of time by not demanding better marching from his troops; and by his loss of practically a day "the cream of the whole campaign was lost." Throughout the seven days' battles his operations were marked by a want of vigour and a lack of initiative, which proved all the more fatal, because to Jackson, fresh from his valley triumphs, was assigned by Lee's generosity the shortest route and the largest force, with the opportunity of winning the most brilliant victory of the war. Lee did not write his report of this campaign till eight months later, when "Jackson's great military genius had manifested itself undimmed by any spell," and deliberately glossed over the failure, which had been so brilliantly atoned for. The author rejects Dabney's explanation, that Jackson's failure was due to physical exhaustion, and apparently inclines to the view that Jackson wished to spare his own troops, and thought that the garrison of Richmond ought to bear the brunt of the fighting.

His criticism of the Gettysburg campaign leaves nothing to be desired, except, perhaps, that he had been rather less partial to his corps commander. For he accepts Longstreet's defence of his conduct on the 2nd July as if it were in itself, and without further proof, an irrefutable answer to the censures which have been passed upon him. He condemns the campaign, as planned, because it ignored the sole military advantage possessed by the Confederates, viz., the interior lines. In his opinion, both Lee's invasions of the North were a mistake, and a large part of his victorious army should have been sent to Tennessee and Kentucky, with a view to forcing the Federal forces of the west back upon the Ohio. He quotes the success gained at Chickamauga by the addition of only five infantry brigades, without any artillery, as an indication of what might have been done earlier in the war with the much larger forces then available. One of the chief causes of the failure of the Gettysburg campaign was Stuart's raid round Hooker's rear. Lee's Gettysburg campaign was compromised, just as Hooker's Chancellorsville campaign had been lost, by the absence of his cavalry. Another cause was the failure of the Confederate staff to keep their commander informed of all that was taking place. Hill's movement upon Gettysburg, on the 1st July, which precipitated the battle, was made without either Lee's sanction or knowledge. Ewell throughout the three days of battle fell far short of his duty. The author considers that Stuart would have proved a much more efficient successor to Jackson. The Federal position on the 2nd and the 3rd July was greatly superior to that of their opponents, and the one weak point in Meade's line, the salient on Cemetery Hill, was never attacked. The Confederate management of the battle of the 2nd was "conspicuously bad." The type of the attack ordered was "the echelon or progressive type, as distinguished from the simultaneous." The latter, in the author's opinion, should be the type for any battle not commenced till the afternoon. He agrees with

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Longstreet that the attack on the 3rd, as carried out, was doomed to failure, and places the chief responsibility upon Ewell and Hill.

The author holds that each summer campaign in Virginia marked a Confederate crisis, but *the* crisis of the war took place during the fighting round Petersburg on the 15th to the 18th June, 1864. "At no other period was there such depression among the people at home, in the army in the field, or among the officials of the Government in Washington." Had Grant sustained at Petersburg "a second defeat, more bloody, more signal, and more undeniable than Cold Harbour" (and such would surely have been the case, even if Beauregard had been reinforced only by Longstreet's Corps), he believes that public support at the North would have been withdrawn from Grant, whereas the Federal leader, by outwitting Lee, secured a position from which he was never dislodged.

The lack of good maps is a distinct disadvantage to this book.

MILITARY HISTORY APPLIED TO MODERN WARFARE. A Guide to the Study of Military History, exemplified by Studies of the Campaigns of Austerlitz, Jena, Vimiera, Corunna, Salamanca, Waterloo, and the Shenandoah Valley. By the late Capt. J. W. E. Donaldson. 2nd edition, revised and enlarged by Capt. A. F. Becke, late Royal Field Artillery. 395+xxiv. pp., with maps and plans. 8vo. London, 1907. Rees. 8s. 6d.

A new edition of this publication. It contains a completely new set of maps and plans.

POLITICAL.

MODERN GERMANY. 2nd edition. By J. Ellis Barker. 552 pp. 8vo. London, 1907. Smith, Elder. 10s. 6d.

This book presents, in exhaustive and comprehensive detail, an account of Germany's political and economic problems, of her foreign and domestic policy, and of her ambitions and causes of success. The writer emphasizes his apparent pro-British tendencies by adopting the name of J. Ellis Barker, but his German origin, sufficiently marked by his real name, O. Eltzbacher, under which the first edition of the book was presented to the public, is apparent throughout his composition.

There is much interesting matter in the work, particularly that contained in the earlier chapters dealing with the fundamental principles of Germany's foreign policy and her relations with the various European Powers, and the portions of the book dealing with the German Navy League, operations over sea, and the Emperor as a political factor are instructive.

On the whole, the work is well worth study.

AN OBSERVER IN THE NEAR EAST. Anonymous. 309 pp., with map, and illustrated by photographs by the author and Princess Xenia of Montenegro. 8vo. London, 1907. Eveleigh Nash. 16s.

This somewhat startling work claims to reveal the actual state of affairs in the Balkan Peninsula at the present time.

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After a long journey through Montenegro, Northern Albania, Dalmatia, Bosnia, Herzegovina, Servia, Bulgaria, Roumania, Turkey, and Macedonia, the author, who states that he has had private audiences with the various kings and princes of the Balkan States, and with the Sultan, as well as with almost every member of the various cabinets, and that he has been the guest of brigands in Albania, endeavours to place on record what he terms the actual and serious truth. He anticipates that some of his facts will come as revelations even to Balkan diplomatists. The views expressed are decidedly anti-German, and by no means favourable to Austria.

Summarizing his confidential enquiries, the author finds the present position as regards Macedonia a very serious one, and states that Bulgaria has undoubtedly decided to adopt a firm course, which must inevitably lead to war "during the present year" (1907). He is a bold man who ventures to prophecy with regard to the Balkans, and this prophecy has not been fulfilled.

THE DANGERS OF A EUROPEAN WAR ARISING FROM QUESTIONS OF COLONIAL INTEREST (Pericoli di Guerre Europee, derivanti da questioni coloniali). By Professor Gustavo Coen. 70 pp. 8vo. Rome, 1907. Officina poligrafica Italiana. 8s. 4d.

The keynote of this treatise is the necessity for German colonial expansion, and the author points out how such expansion must clash with the interests of Great Britain. The present political situation in Europe is fully dealt with, and the question of German influence in the Middle and Far East discussed.

The subject is treated under six headings, viz.:—

Armaments and a pacific policy.
Pan-germanism.
The German colonies.
The vulnerability of Holland and her colonies.
The rivalry between England and Germany.
Can war be avoided?

BONAPARTE IN EGYPT, AND THE EGYPTIANS OF TO-DAY. By (the late) Haji A. Browne. 399 pp. 8vo. London. 1907. Fisher, Unwin. 10s. 6d.

The first part of this book deals with the French Expedition of 1798, and describes the political conditions then obtaining in Egypt. A description is given of the Battle of the Pyramids, where Napoleon shattered the power of the Mamaluks. The author asserts that the Egyptians were at first not unsympathetic to the French, owing to oppressions they had suffered from the Mamaluks, but that the tactless behaviour of the French, and especially of Napoleon, soon caused a violent reaction. This was further increased by Kléber, when he assumed the reins of government, and it finally culminated in his assassination. The author dates the beginning of the dislike of the English from the time when the English Government stopped the evacuation of Egypt by the French in 1799—1880. He touches

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but lightly on the history of Egypt from the evacuation by the French to the beginning of the dual control.

The three healthy influences at present at work in Egypt, in Haji Browne's opinion, are :—

1. The increased acquaintance of the people with European civilization.
2. Their increased knowledge of the social and political condition of the Mahommedan countries of the world.
3. The development of the Arabic press.

He also enumerates the unhealthy influences at work, such as the influence of an anti-Turkish press, the irreligious system of education, the action of certain missionaries, the behaviour of some Englishmen, and the want of respect shown to local and religious prejudices. The Tabah affair, and the Denshawi affair also, in the author's opinion, did a great deal of harm, which was increased by the injudicious action of certain people in England in encouraging agitation against Lord Cromer. He sums up the failure of our administration, "that it has failed in two vitally important matters. It has not in any way qualified the people or any class of the people to undertake the government of the country. It has not educated the people or done anything whatever to ensure the permanency of the good that has been done."

Haji Browne concludes with an appreciation of Lord Cromer's work, and states that though he has himself been an open advocate of autonomous government for Egypt, yet he does not think that the people are yet ripe for autonomy.

The book is a very interesting one, and is written in a clear, readable style.

STRATEGICAL AND TACTICAL.

ENGLAND IN THE SEVEN YEARS' WAR : A STUDY IN COMBINED STRATEGY. By Julian S. Corbett. 2 vols. 476 and 407 pp., with maps and plans. 8vo. London, 1907. Longmans, Green. 21s.

The author is the well-known lecturer in history to the Royal Naval War College, and the two volumes in which he deals with his subject are of especial interest, since we probably see reflected therein the most modern school of naval thought upon the subject of Imperial strategy and amphibious operations.

The Seven Years' War is dealt with for the benefit of those who seek insight into the higher principles of the art of war, and the author contends that no contest—at least for a maritime power—so clearly illustrates the function of the fleet in war. He points out that a study of the history of the wars which gave Great Britain her position to-day reveals the fact that the function of the fleet is threefold—firstly, to support or obstruct diplomatic effort; secondly, to protect or destroy commerce; thirdly, to further or hinder military operations ashore.

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That the destruction of the enemy's fleet is the best way of ensuring that your fleet will be in a position to discharge its threefold duties is admitted, but that command of the sea is only a means to an end, the author says, is apt to be overlooked, since of late years the world has become so impressed with the efficacy of sea power that there is an inclination to forget how impotent it is of itself to decide a war against great continental states, and how tedious is the pressure of naval action, unless it be nicely co-ordinated with military and diplomatic pressure. It is for these reasons that the author attaches so much importance to a study of the Seven Years' War. From first to last we were more or less free to use our fleet directly upon the ulterior objects of the war, and throughout the struggle what is called the primary function, that is the domination of the enemy's main fleet, scarcely ever rose above the level of containing operations. From the time, however, when Pitt obtained control and assumed direction of the war he exercised almost undisturbed control of army, navy, and diplomacy; in his hands we see the fleet slipping neatly into its place, shoulder to shoulder with its comrades; it is never used without some close relation to a military or diplomatic end, and conversely the army and diplomacy are always being employed to secure some point which will either strengthen the naval position or relieve the fleet of some irksome preoccupation. Here lay the pith of what Pitt called his system.

For Pitt, army and navy were the blade and hilt of one weapon, and the war under his direction is described as a most brilliant lesson of the way in which the weak army of a strong naval power can be used, of how continental armies may be made to feel the shock of fleets, and of how superiority at sea, combined with expeditionary action, may be made to thwart continental cabinets, to tangle their strategy, and upset their moral balance.

These volumes should prove of interest to all military students. The state of Europe between 1754 and 1763 is dealt with comprehensively enough to show clearly the aims of the several continental rulers, and how each belligerent, both before and during the progress of the struggle, strove to turn the varying aims and ambitions of continental policy to account. The author gives, as it were, a bird's-eye view of the war, in which each naval and military operation is given its relative position in the general scheme, which, so far as Pitt was concerned, was based on the co-ordinated activity of the navy, army, and diplomacy, and consequently on what the author regards as the true application of sea power for a maritime nation.

Pitt's system of undivided control has been exercised in much the same way by Napoleon, the German Emperor, and the Emperor of Japan; but it should be remembered how entirely the conditions of military service in Europe have changed since the period under consideration, for at that period the size of European armies was determined by the length of the national purse, and England, being as well or better off, in this respect, than any other nation, could put

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as large an army in the field as most continental nations. Thus some of the author's arguments are not applicable to modern conditions

HISTORY OF FORTRESS WARFARE FROM 1885–1905, INCLUDING THE SIEGE OF PORT ARTHUR (Geschichte des Festungskrieges von 1885–1905 einschliesslich der Belagerung von Port Arthur). By Lieut.-General H. V. Müller. 260 pp. 1 plan and 29 sketches in text. 8vo. Berlin, 1907. Mittler. 7s. 6d.

The introduction of high-explosive shell and of defensive armour for guns effected a revolution in fortress construction. The years 1885–1890 were a transitional period. Since then the chief influences at work have been the invention of smokeless powder, increased rate of fire from guns and high-angle fire of howitzers, and further development of armoured turrets and cupolas. Examples are drawn from the principal European fortresses. The book closes with a study of the defence system and siege of Port Arthur.

INFANTRY IN THE ATTACK. By Brigadier-General H. R. Kelham, C.B. (A lecture delivered before the East and West of Scotland Tactical Society). 8 pp. Folio. 1907.

This is an interesting lecture, and gives an example of the writer's own experience of an infantry attack at Witteput. There is a note on Suvoroff.

AERIAL NAVIGATION.

NAVIGATING THE AIR. A Scientific Statement of the Progress of Aeronautical Science up to the Present Time. By the Aero Club of America. 259 pp., with photographs and diagrams. 8vo. London, 1907. Heinemann. 6s.

This book opens with a general review of the progress made in aerial navigation, and it then has a succession of chapters which go more into detail and touch on such points as dirigible airships, aeroplanes, balloons, propulsion by motors, air currents, etc., and gives accounts of experiments made by various aeronauts.

An interesting statement is made on p. 173, that from a balloon the bottoms of lakes are clearly visible, "a fact that makes airships the natural enemies of submarine vessels"; but the question arises whether this visibility would still obtain when over the sea, unless the sea was perfectly calm.

Many other points of interest to aeronauts are touched upon, and, having been compiled by people with practical experience of aeronautics in all its forms, they would seem likely to be of value.

Among the contributors are the Brothers Wright, Dr. Bell, Lieut. Lahm, Mr. Channte, etc.

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THE TECHNIQUE OF THE BALLOON (La technique du ballon). By Lieut.-Colonel Espitallier. 458+xvi. pp. 8vo. Paris, 1907. Doin. 4s. 2d.

A very useful book, going thoroughly into the theory of balloons, their management when free, methods of preserving equilibrium, cutting of material for different forms of balloons, and construction of nets, valves, etc. A short chapter on the manufacture of hydrogen finishes a book which should be a standard work for balloon builders and aeronauts.

MISCELLANEOUS.

OVER-SEA BRITAIN. A Descriptive Record of the Geography, the Historical, Ethnological, and Political Development, and the Economic Resources of the Empire. By E. F. Knight. xii.+324 pp. 9 coloured maps, specially prepared for this volume, include rainfall, temperature, and vegetation. 8vo. London, 1907. John Murray. 6s.

The present volume deals with the Nearer Empire, in which term are included the Mediterranean, British Africa, and British America. The author, who is the well-known traveller and war correspondent, gives a comprehensive account of the British possessions beyond the seas, and explains what the British Empire is; how it came to be; the history of its growth; the physical, political, and commercial geography of its various parts. The eager scramble for African colonies within the last few years, of which other European Powers have secured their share, is well discussed, and the present volume is thoroughly interesting throughout.

MILITARY REPORT ON SOMALILAND. Vol. I. Geographical, descriptive, and historical. General Staff. 273 pp., with maps and illustrations. 8vo. London, 1907. Stationery Office. 2s.

This volume deals with geography, communications, riding and transport animals, climate, trade, inhabitants, history, administration, finance, money, weights and measures, fortifications and barracks, navy, and native warfare. In Appendices are notes on the genealogy of the tribes, fauna, flora, water supply, horse sickness, kit, etc., etc.

THE OFFICER; HIGHER COMMANDERS AND THEIR ASSISTANTS IN GERMANY (L'Officier, le haut commandement, et ses aides en Allemagne). By Jules Poirier. 240 pp. 8vo. Paris, 1907. Librairie mondiale. 2s. 6d.

The contents of this book are as follows:—

Part I., Chapter 1.—Education of the Young Officer.

Chapter 2.—The Officer—

(i.). Officers of Active List (ranks, promotion, pay, pensions, etc.).

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Chapter 3.—Instruction of Officers—
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Chapter 2.—Their Assistants:—
(i.). The Staff (its education and organization).
(ii.). The Adjutantendienst.
(iii.). The Corps of Feldjäger.

HAND-GRENADES, AND THEIR UTILIZATION IN THE WAR IN MANCHURIA (Les grenades à main). By Capt. M. C. Curey (French Artillery). 26 pp. 12 figures. 8vo. Paris, 1907. Berger-Levrault. 9½d.

After a short historical introduction, the author gives description and drawings of some of the hand-grenades used by the Russians and Japanese.

Capt. Curey states:—"This antique engine of war has been nearly completely abandoned by European armies, except, perhaps, by the British." His authority for this is the *Armeeblatt*, No. 37, of 1906, which he quotes to the following effect:—"The English made great use of hand-grenades in the Soudan; the grenades were formed of segments and contained a bursting charge of guncotton. . . . The grenades were exploded by a time fuze. They weighed between 4 and 6 ozs., and could be thrown 100 yards by hand, or 200 yards by a catapult."

THE NEUTRALITY INCIDENTS OF THE RUSSO-JAPANESE WAR (Les incidents de neutralité de la guerre russo-japonaise, 1904). By Lieut. Henri Carré, 131st Regt. Infantry. 110 pp. 8vo. Paris, 1907. Lavauzelle. 2s. 1d.

This work contains solutions of the various problems of international law set during the first year of the Russo-Japanese War.

The rights of belligerents are clearly defined. The author admits that force must always remain the *ultima ratio*.

RAILWAY ENTERPRISE IN CHINA. An Account of its Origin and Development. By Percy Horace Kent. 304 pp. 5 maps. 8vo. London, 1907. Arnold. 12s. 6d.

The author, who, as a resident in China, appears to have been exceptionally well situated for obtaining reliable material for the compilation of the present volume, has supplied a long-felt want, *i.e.*, an up-to-date and accurate record of the origin and growth of railway enterprise in China.

The Appendices contain copies of the more important railway contracts and other documents, which greatly enhance the value of

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the work as a book of reference. There is also a general map illustrating railways in China and Manchuria, showing the lines constructed, under construction, and projected.

A good index completes this excellent publication.

THE RAILWAYS OF AFRICA: CONSIDERATIONS THAT SHOULD AFFECT OUR RAILWAY POLICY IN OUR AFRICAN COLONIES (Die Eisenbahnen Afrika's, Grundlagen und Gesichtspunkte für eine kolonial Eisenbahnpolitik in Afrika). By von Posadowsky. 262 pp., with map. 4to. Berlin, 1907. Official publication.

This book is a memoir drawn up for the Reichstag. Part I. is a survey of all the existing railway systems in Africa, with statistical information as to cost of construction, capacity, and remunerativeness of the lines. Part II. deals with railway policy in Africa in its relation to German colonial and foreign policy. The book is valuable as a work of reference.

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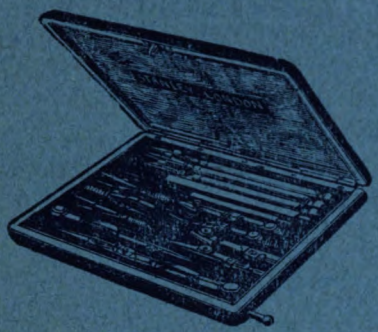

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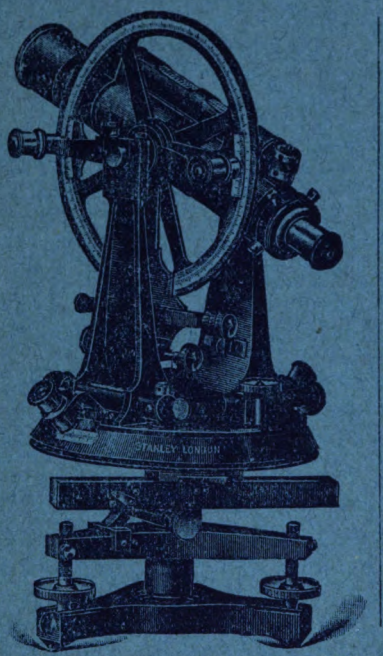

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Vol. VII. No. 4. APRIL, 1908.

CONTENTS.

	PAGE.
1. **Ammonal.** By Lieuts. C. HORDERN and B. H. FOX, R.E. (*With Photos*) ...	197
2. **Notes on Field Equipment of Royal Engineers.** By Lt.-Col. W. BAKER BROWN, R.E.	205
3. **Imperial Defence.** By Lieut. W. G. S. DOBBIE, R.E.	219
4. **Military *v.* Naval Home Defence.** By Lt.-Col. E. H. BETHELL, D.S.O., *p.s.c.*, late R.E.	222
5. **Report on an Improvised Search Light on Board the R.I.M.S. "Minto."** By Major W. P. BRETT, R.E.	225
6. **R.E. Corps Libraries and Publications.** By Lt.-Col. B. R. WARD, R.E. ...	228
7. **Transcript:**—German Cavalry Steel Bridge Equipment. By Major E. HARTMANN. (Translated from *Kriegstechnische Zeitschrift* by Bt. Lt.-Col. G. H. FOWKE, R.E.)	235
8. **Notices of Magazines**	253
9. **Correspondence:**—The Helio-Chronometer. By Col. E. D. MALCOLM, C.B., late R.E.	259

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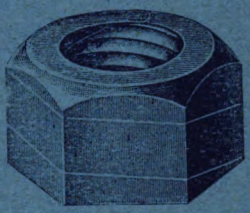

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CONTENTS.

PAGE.

1. AMMONAL. By Lieuts. C. Hordern and B. H. Fox, R.E. (*With Photos*) ... 197

2. NOTES ON FIELD EQUIPMENT OF ROYAL ENGINEERS. By Lt.-Col. W. Baker Brown, R.E. 205

3. IMPERIAL DEFENCE. By Lieut. W. G. S. Dobbie, R.E. 219

4. MILITARY *v.* NAVAL HOME DEFENCE. By Lt.-Col. E. H. Bethell, D.S.O., *p.s.c.*, late R.E. 222

5. REPORT ON AN IMPROVISED SEARCH LIGHT ON BOARD THE R.I.M.S. "MINTO." By Major W. P. Brett, R.E. 225

6. R.E. CORPS LIBRARIES AND PUBLICATIONS. By Lt.-Col. B. R. Ward, R.E... 228

7. TRANSCRIPT :—

German Cavalry Steel Bridge Equipment. By Major E. Hartmann. (Translated from *Kriegstechnische Zeitschrift* by Bt. Lt.-Col. G. H. Fowke, R.E.) 235

8. NOTICES OF MAGAZINES :—

Memorial de Ingenieros. By 'M.' 253
Revue du Génie Militaire. By Capt. J. E. E. Craster, R.E. 254
The Electrician. By Capt. R. C. Hammond, R.E. 257

9. CORRESPONDENCE :—

The Helio-Chronometer. By Col. E. D. Malcolm, C.B., late R.E. 259

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AMMONAL.

By Lieuts. C. Hordern and B. H. Fox, R.E.

The following remarks on Ammonal, an explosive lately introduced for the first time into India, may be of interest to R.E. officers who are unacquainted with it. The Indian agents for this substance state that it has already been in use in England, for the last two years or so, as a substitute for dynamite in mining work.

Nature of Ammonal.

Ammonal consists of a mixture of ammonium nitrate, finely-divided aluminium, and a small percentage of vegetable charcoal, in proportions which vary in the different grades of the explosive. It thus differs essentially from dynamite, nitro-glycerine, or guncotton, in which the explosive ingredient is a chemical compound.

In appearance, it is a powder of a light chocolate colour, of the consistency of fine river sand, the particles of metallic aluminium being clearly visible on a close examination.

It is intended for use wherever dynamite, or similar explosives, would be suitable; no claims are made for it as a propellant.

It is made up for use in 2-oz. cartridges, which consist of cylinders of well-waxed paper filled with the explosive. Nine different grades are manufactured; the cartridges of No. 5 ammonal, which we saw used, were $5\frac{1}{2}$ inches long by $\frac{7}{8}$-inch diameter, and were packed in watertight tins, each containing 5 lbs. of ammonal.

Claims Made for Ammonal.

1. It is cheaper to manufacture than dynamite, and costs about £5 a ton less.

2. No. 5 ammonal, which was used at Craigmore (*vide* Appendix A), is about 20 per cent. stronger than No. 3—the grade used in the quarrying experiments—and about 25 per cent. stronger than dynamite.

3. It is eminently safe both to manufacture and to handle, as it is unaffected by flame or shock, and can only be detonated by a detonator.

4. Its action, in all cases, is slower, more rending, and less shattering than that of dynamite—resembling, in this respect, that of gunpowder—while it possesses the strength of a nitro-explosive. The greater the proportion of aluminium the slower is its action.

5. It can be rendered harmless at once if necessary—*e.g.*, in case of a miss-fire—by wetting.

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6. It evolves no noxious gases, and is therefore very suitable for use in tunnels and such places.

7. It does not freeze, and is unaffected by climate.

Remarks as to Claims Made.

1. As to cost, we have no *data* beyond this statement by the agent for the Ammonal Company.

2. We consider that the experiments—of which details are given below—show that ammonal is certainly stronger than dynamite.

3. Ammonal undoubtedly will not burn. To a lighted match it is indifferent, and we saw a length of fuze burnt, while embedded in a quantity of the explosive, with no effect except upon the nervous systems of the spectators. Advantage is taken of this property of ammonal in making up charges (see below).

The same lot of explosive, which was lying loose upon a stone slab, failed to detonate when violently hit with a hammer; a fuze and detonator were then inserted and detonated it successfully.

4. As to this, the Craigmore experiments do not give much information; the action, in fissured rocks and in the quarrying experiments, tends to confirm the claims made, as might perhaps be expected from the fact that steam is one of the main products of detonation (see Remark 6 below).

5. This is obvious from the chemical composition, and is certainly an advantage where miss-fires are concerned. In this respect, moreover, ammonal is clearly superior to dynamite from the point of view of safety, there being nothing corresponding to the exudation of nitro-glycerine, which is such a well-known defect of the latter.

At the same time ammonal cartridges are quite waterproof enough to be used in very damp bore-holes, and are easily used under water if the charge is made up in a waterproof covering.

6. The products of detonation vary in the different grades, but may be generally represented by the equation

$$3 . NH_4 . NO_3 + 2Al = 3N_2 + 6H_2O + Al_2O_3.$$

An advantage of ammonal is that it does not produce the familiar dynamite headache.

7. We had no opportunity of verifying this, but on the face of it, the statement seems probable, damp excepted.

MODE OF USE.

Ammonal is used in exactly the same way as dynamite, except as regards

(*a*) Amount of charge;

(*b*) Position of detonator.

The tabulated experiments show all that is wanted as to (*a*).

(*b*). A typical charge is shown in the figure. It will be seen that

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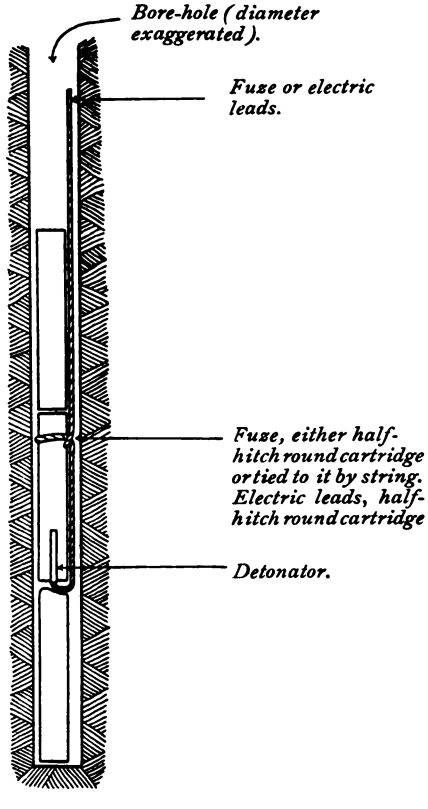
the detonator is placed at the bottom of the centre cartridge, an arrangement only possible because the fuze, burning past the upper cartridges, cannot fire them. This method has the following obvious advantages:—

(1). The tamping of the charge is not done directly on to the detonator.

(2). The better-tamped position of the detonator is claimed to give some extra pressure when the charge is fired.

(3). The portion of the charge, above the detonator, can be withdrawn by pulling on the fuze (or electric leads) without danger, as the pull does not come on the detonator, but on the cartridge itself.

(4). The accidents which occur when—as sometimes happens—unskilled men proceed to jump holes which are already charged, are prevented, as they cannot hit the detonator.


Bore-hole (diameter exaggerated).
Fuze or electric leads.
Fuze, either half-hitch round cartridge or tied to it by string. Electric leads, half-hitch round cartridge
Detonator.

The bore-hole need not be made specially large to allow for the thickness of the fuze, as the latter can be pressed into the sides of the cartridges, which (ammonal being a dry powder) readily yield space for it.

The detonator used should not be weaker than No. 6 (commercial), and should be quite embedded in the powder.

In wet places, great care should be taken not to break the cartridges, and the one which contains the detonators should be specially protected. The Ammonal Company supply waterproof tubing for the purpose.

It is usual to ram down a piece of crumpled paper gently on top of the charge before tamping.

The instructions issued by the company embody the above points, and are headed "Keep your powder dry."

CONCLUSIONS.

Regarding ammonal from a service point of view, we contrast it with

(*a*) Guncotton;
(*b*) Gunpowder;
(*c*) Dynamite.

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(*a*). The strength of ammonal is probably about equal to that of guncotton. As regards dry guncotton, it is decidedly safer. It is true that in the experiments described in Appendix B a bullet did (probably only imperfectly) detonate a quantity of ammonal; but whereas in the case of dry guncotton (primers, for instance) or dynamite such a result would be almost a foregone conclusion, in the case of ammonal it undoubtedly was exceptional, and altogether unexpected by those best qualified to judge. Ammonal has also the advantage over wet guncotton that no primer is required. On the other hand, the necessity of tamping, and the nature of its action, render ammonal unsuitable for hasty demolition work, with the possible exception of the "towers" of the N.W. Frontier; it cannot, therefore, take the place of guncotton in the equipment of sapper, cavalry, or pioneer units.

We have no *data* as to its use from a submarine mining point of view; it is not likely to be as good as guncotton, except perhaps for removing sunken rocks.

(*b*). Wherever gunpowder would be used, ammonal could probably be substituted with advantage. It is less bulky to transport, far safer, more powerful, and not dissimilar in its action. The necessity of carrying detonators may perhaps detract somewhat from these advantages.

(*c*). Where hasty demolitions are concerned, ammonal does not compare favourably with dynamite. But for blasting purposes—and it is in this direction that the claims of ammonal are urged—it is on the whole distinctly superior. Its safety renders it particularly suitable for use in roadmaking and similar work on active service, more especially where coolie or other unskilled labour is employed; even under fire the risk in using it is reduced to a *minimum*.

To sum up, it would appear that wherever dynamite is carried for blasting or quarrying, ammonal might, with great advantage, be substituted; and that in all demolition work, where gunpowder would be suitable, ammonal—preferably in this case one of the slower grades—might take its place. The chief drawback to ammonal seems to be its susceptibility to damp; it is, however, so carefully packed that in all probability there is little to fear in this respect.

It may be added that ammonal is manufactured by the Ammonal Explosives Co., of 29, Great St. Helen's, London, E.C., and that the Indian agents are the South Indian Export Co., Ltd., P.O. Box 37, Madras. To the representative of the latter firm, the writers are indebted for such of their information as was not gathered from the experiments which they witnessed.

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APPENDIX A.

RESULTS OF SHOTS FIRED AT CRAIGMORE, ON THE OOTACAMUND EXTENSION OF THE NILGIRI RAILWAY.

Witnessed by Lieuts. Hordern and Fox, R.E., on 14th December, 1907.
Explosive.—Ammonal No. 5.
Rock.—Hard grey granitic.
Bore-Holes.—1 inch diameter in every case.
Object.—Removal of rock in cutting (*i.e.*, blasting pure and simple).
All charges fired by time fuze.

No.	Depth of Hole.	No. of 2-oz. Cartridges Ammonal used.	Estimated corresponding No. of Dynamite Cartridges necessary.	Remarks.
	′ ″			
1	3 0	4	5	Miss-fire ; fuze cut by explosion of No. 2. Charge drawn ; fired ; results good.
2	4 0	4	5	Results very good ; quite equal to dynamite.
3	3 0	2	3	
4	3 0	2	3	
5	2 0	2	3	Results poor, owing to miss-fire of No. 1, which failed to clear rock in front.
6	1 6	1	2	
7	3 10	4	4	Excellent.
8	1 0	1	1	Old hole ; fired to shift loose stuff ; good.
9	3 6	3	4	Results good ; equal to dynamite.
10	4 0	3	4	
11	4 0	3	4	
12	4 0	3	4	
13	4 3	3	4	Bad. L.L.R. large, especially No. 13 ; charges too small. Deeper holes and probably 5 and 6 dynamite cartridges would have been necessary.
14	4 0	4	5	
15	4 6	4	5	Good.
16	4 6	3	4	Small L.L.R. ; results average.
17	3 6	3	4	Good.
18	4 0	4	5	Large L.L.R. ; very good.

Exact L.L.R.'s cannot be given, owing to situation of rock ; they probably averaged 3 to 4 feet.

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APPENDIX B.

EXTRACT FROM NOTES BY LIEUT. PAKENHAM-WALSH, R.E.

The second series of experiments was carried out on the same railway at Fern Hill, Ootacamund, on the 20th December, under arrangements made by Capt. Watson, 64th Pioneers, the object being, in this case, more for quarrying work, *i.e.*, to cut large blocks of stone suitable for masonry, rather than to break up masses of rock.

The details and results of these operations are given in the following Table.

Results of Shots Fired at Trials Conducted at Fern Hill, Ootacamund, with Ammonal Explosive No. 3, against Grey Granite.

Diameter of Bore-Holes.—1 inch.
Object.—Quarrying stone for use.

No. of Shot.	Depth of Holes.	Ammonal No. 3. No. of 2-oz. Cartridges actually used.	Corresponding No. of Dynamite Cartridges estimated necessary.	Result.
	′ ″	First	Quarry.	
1	4 0	3	3½	Fired electrically. Simultaneously Nos. 1 and 2 formed good cracks, extending for 5 feet in all directions. No. 3 shattered the rock.
2	3 0	3	3	
3	4 0	3	3½	
4	3 9	2	3	Fired electrically. Nos. 4 and 6 made good cracks, about 3 feet in all directions; 5 and 7 only cracked slightly in fissure and at bottom.
5	3 9	2	3	
6	1 6	1	1	
7	2 0	1	2	
8	In old hole of 5	3½	—	Fired electrically, and broke up rock well.
9	In old hole of 7	1½	—	
10	3 3	3	3½	Fired with time fuze; split rock.
		Second	Quarry.	
1	2 0	1	2	Fired consecutively by time fuze. The rock was split up excellently.
2	3 0	3	3	
3	4	4	4	
4	4 0	4	4	

Owing to the situation of the rock, the L.L.R.'s cannot be given, but the number of dynamite cartridges estimated gives a fair comparison.

In addition, a charge of 6 ozs. was made up in a waterproof tube, and fired successfully under water.

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Photo 1 shows the second quarry after the charges were exploded; but much of the stone in the foreground had been previously cut, as may be seen by the tooling on it.

Photo 2 shows the two pieces of rock broken away above a bore hole, with the leads of the electric detonator passing through them still intact.

These experiments, however, were not of a nature to demonstrate its value for military purposes, and accordingly I arranged with the representative of the firm to carry out the following series of experiments, which was done at the Cordite Factory, Aruvankad, on the 27th December, in the presence of Major Babington, C.I.E., R.A., Superintendent, and nearly all the principal officials of the factory.

At Fern Hill, No. 3 ammonal was used, and at the factory No. 5; No. 7 detonators were used throughout, and time fuze in all the experiments on the 27th.

Experiment No. 1.

A tin containing 5 lbs. of ammonal was placed on a bank, and five rounds fired into it with a ·303 rifle at about 100 yards. The ammunition was Mark II., with a hollow-nosed bullet.

Three rounds passed through the tin and explosive, the first two without effect. The third exploded the charge, but the detonation was incomplete, the report being less loud; and some observers distinctly saw a large amount of flame, of which there is none when complete detonation takes place. This was a complete surprise to many present, as it was supposed that the material was insensitive to shock alone; I understand it has been tested in this way on several occasions before, and that this is the first time it has been exploded by a bullet. This result is important, and is referred to in the conclusions given above.

Experiment No. 2.

A piece of double bull-headed rail, weighing 65 lbs. per yard (web ¼ inch thick), 9 feet long, was placed loosely on the ground, on edge, in the position it would be in a line, but no steps were taken to fix it down.

A charge of 8 ozs. (four cartridges) was lashed to the side against the web, in the same manner as guncotton would be, and fired, no tamping being used.

The result was distinctly curious. The rail was knocked over, and 9 inches of the web were completely removed, being apparently pulverized, as no trace could be found; but neither of the flanges was cut, though the upper one had a wide crack, extending nearly across it, and the rail was slightly bent. The whole effect was very local, hardly sufficient to derail a train, and the rail was unaffected at a distance of 6 inches on either side of the centre of the charge.

Experiment No. 3.

The same rail was again placed in position, and this time wedged firmly to represent as nearly as possible the conditions of a rail fixed to sleepers. The charge was placed at a reasonable distance from the previous damage, so that the latter should not affect the result, and was

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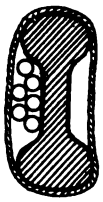
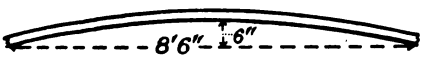
12 ozs. (six cartridges).* These were tied together as in sketch, and lashed to the side of the rail in the usual way.



The result was that the web was again completely destroyed, apparently pulverized, for a distance of 8 inches, while the upper flange was removed for 12 inches. Something was heard crashing through some trees near by, and this is presumed to have been part of the flange, but it was not found.

The lower flange was again uninjured, and there was no sign of injury beyond the actual area destroyed; but the rail was bent as shown in sketch, a deflection of 6 inches in 8½ feet.



Both these experiments were carried out in a small passage about 2 feet 6 inches wide, behind a stop butt of earth riveted with poles about 7 feet high. The other side was a perpendicular bank in the solid earth about 10 feet high. No appreciable damage was done to either the stop butt or the bank. The effects on the rail are clearly shown in *Photos* 3 and 4. Note the crack in the top flange caused by experiment No. 2.

Experiment No. 4.

The remaining ammonal on the spot (50 ozs.) was put in one of its own 5-lb. tins and packed tightly up against one side with damp paper, the side with the explosive being placed nearest the firing point. In front of the tin was placed a ¾-inch board.

Nineteen rounds were then fired at a range of about 150 yards, with the following results:—

Series.	No. of Rounds Fired.	No. of Rounds Penetrating Tin.	Nature of Ammunition.
1	5	3	Mark II. hollow-nosed bullet.
2	4	1	,, ,, ,,
3	5	4	Service ammunition.
4	5	5	,, ,,

The one round in Series 2, which hit the tin, knocked it over. Before Series 4 the tin was turned so that it was end on to the firing point.

None of these rounds succeeded in detonating the explosive, though, as is shown, 13 of them passed through it, and the back of the tin was considerably torn about, and the powder leaking out.

As it was thought the wet paper might have affected the powder, a detonator was put in and the charge fired. This time the detonation was complete, there being no flame, as in experiment No. 1.

* The *Manual of Military Engineering* lays down one-third of a 1¾-lb. slab (*i.e.*, about 9½ ozs.) as the proper charge where guncotton is used.

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NOTES ON FIELD EQUIPMENT OF ROYAL ENGINEERS.

By Lieut.-Colonel W. Baker Brown, R.E.

Introductory.

The reorganization of the Royal Engineers has at last crystallized in the form of *War Establishments*, 1907, and the various mobilization store tables (A.F. G.1098) of the same date.

This reorganization, which began before the end of the South African War, has been subject to many vicissitudes, owing to changes of army policy during the past seven years, and is probably, like all mundane affairs, open to improvement.

An attempt has, however, been made to maintain a consistent relation between men, stores, and transport, and while cutting off everything which is either redundant or luxurious, to include all improvements suggested by recent experience in South Africa and elsewhere.

The reorganization has also been applied simultaneously to all branches of the R.E.

The present is, therefore, a convenient opportunity to take stock of what has been done, and thus to establish a foundation on which any future changes and improvements can be built.

It is thought also that, as store tables are somewhat dry reading, many R.E. officers may be glad to have the essential points put before them in a concentrated form.

Summary of the Changes dealt with.

A considerable number of different changes, is embodied in the latest organization.

The most important are :—

1. Changes due to the experience of the war in South Africa, and recommendations embodied in the reports of the Engineer-in-Chief, Director of Telegraphs, and Director of Railways.
2. Changes recommended by the committee, under the presidency of Sir Evelyn Wood, in 1906.
3. Changes in the scale of transport for the Army recommended by the committee, of which Sir F. Stopford was president, in 1906.

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4. Changes of organization of the Army from an army corps to a divisional system.
5. Changes in pattern of arms and accoutrements, and of harness.
6. Changes in patterns of other stores, including many changes of nomenclature embodied in the 1906 edition of the *Vocabulary of Stores.*

It would be tedious to follow each alteration through all the above stages, and it is only proposed to state shortly the present arrangements.

GENERAL CONSIDERATION OF FIELD EQUIPMENT.

The equipment of a unit may conveniently be considered under certain groups :—

1. *Equipment of "Personnel."*—(*a*), arms and accoutrements; (*b*), ammunition; (*c*), rations; (*d*), clothing and baggage; (*e*), camp equipment.

2. *Equipment of Animals.*—(*a*), harness or saddlery; (*b*), stable necessaries; (*c*), forage; (*d*), horseshoes.

3. *Vehicles and their Equipment.*—(*a*), vehicles and components; (*b*), wagon equipment, spare parts, and miscellaneous.

4. *Medical and Veterinary Stores.*

5. *General Tools and Materials.*—(*a*), saddlers; (*b*), farriers; (*c*), shoemakers.

6. *Tools for Military Purposes.*—(*a*), entrenching; (*b*), cutting; (*c*), mining.

7. *R.E. Artificers' Tools.*—(*a*), carpenters and wheelers; (*b*), smiths; (*c*), bricklayers and masons; (*d*), painters; (*e*), tinsmiths and plumbers; (*f*), grindstones.

8. *Materials.*—(*a*) to (*e*), for use with R.E. tools.

9. *Blocks and Cordage.*

10. *Stores for Water Supply.*

11. *Explosives.*

12. *Signalling Stores.*

13. *Survey Stores.*

14. *Special Technical Tools and Stores.*—(*a*), bridging; (*b*), telegraph; (*c*), ballooning; (*d*), electric lighting; (*e*), railway work.

15. *Miscellaneous.*—(*a*), office books; (*b*), stationery; (*c*), packages.

Of the above, the first five subheads may best be considered in their general application to all R.E. units; but the remainder must also be considered in their particular application to each class of unit.

In either case attention is directed to para. 7, Section 1, *War Establishments*, 1907, which states that the organization and equipment adopted is that required for a European war, and represents the normal equipment. Units actually serving in South Africa and elsewhere out of Europe are equipped on a special scale.

If any units equipped on a normal scale are ordered for service in a

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non-European country, amendments suitable for the particular service will be made in their scales of transport and equipment.

The changes necessary for certain of these countries are kept worked out in tabular form at the War Office, but are not issued to units.

The scale of equipment authorized is controlled by Equipment Regulations, but for general convenience the scale applicable to each particular unit is worked out on an Army Form (G.1098) for each class of unit.

The scale of consumable stores and such details as boots, horse-shoes, etc., which was formerly based on a three months' supply, is now reduced to a fortnight's supply, on the understanding that under normal conditions such articles will be replenished by the Army Ordnance Department at short intervals.

1. EQUIPMENT OF "PERSONNEL."

(*a*). *Arms and Accoutrements.*—*Officers* carry the arms and accoutrements laid down in *War Establishments*, 1907, Table V. (*a*), Section II.

W.O.'s, N.C.O.'s, and men are all to be armed, in war, with the new short rifle and bandolier equipment, but the issue of arms to drivers may possibly be limited. N.C.O.'s and men of the dismounted branches will carry the bayonet, but the mounted branches will carry no sidearm. Pistols and swords will not be carried in the field by ranks below officer.

(*b*). *Ammunition.*—Each man will carry on his person 50 rounds; mounted branches carrying this in the bandolier, dismounted in bandolier or pouches. An additional 50 rounds will be carried in regimental reserve for each N.C.O. and man of the dismounted branches only.

(*c*). *Rations.*—The detail of rations, carried in the field by and for the soldier, is given in *War Establishments*, 1907, Table III., Section II. The weight of the one ration per head carried in regimental transport is taken at 2½ lbs. The rations are packed in wooden boxes, which will be used as firewood. The weight of wood carried in this way is taken at 1 lb. per head.

(*d*). *Clothing and Baggage.*—The details of the clothing for officers are laid down in *War Establishments*, 1907, Table V. (*a*), Section II. Each commanding officer is allowed 50 lbs. of baggage in regimental transport, and other officers 35 lbs. each. The details of the clothing of the men are given in *War Establishments*, 1907, Table V. (*b*) and (*c*), Section II. The only articles carried for the men in regimental transport are waterproof sheets, of which one, weighing 2 lbs. 9 ozs., is allowed for each man. Spare boots are carried by all units in the proportion of 3 per cent., with a minimum of six pairs per unit.

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(*e*). *Camp Equipment.*—The camp equipment carried in the field comprises camp kettles and butchery implements. Kettles are provided in the proportion of one to every 3 officers, and one to every 24 men. Butchery implements are provided for each section into which a unit may be divided in the field. Tents do not form part of the normal equipment of the Army, and when they have to be provided, special arrangements must be made for their transport. Blankets are similarly dealt with, but, in this case, the special scale of transport required has been shown as an Appendix to Mobilization Store Tables, A.F. G.1098. Tools for camping will be drawn from the general equipment of each unit.

2. EQUIPMENT OF ANIMALS.

(*a*). *Harness or Saddlery.*—The patterns of harness are rather involved—owing to the peculiar nomenclature adopted in the *Vocabulary of Stores*—the terms A.S.C. and G.S. being used not only to describe sets, but also parts of sets, some of which are common to more than one pattern. But, speaking broadly, there are now only two patterns of harness in use by R.E. units for draught purposes—

Harness, A.S.C., wheel, double sets.
Harness, breast, pole draught, R.A., double sets.

The latter is used only for the technical vehicles on the limber principle, that is, at present, the double tool cart and the cable wagon; the former is used for all other vehicles. Both patterns are normally for driving from the horse, but a few pairs of driving reins and some long whips are included for driving from the box.

The pack saddlery, used by R.E., is "Pack saddlery, G.S.," with which are used "Bars, hanging," "Chests, pack transport, Clarkson," and "Racks, entrenching tool, R.E., wood, small." The saddlery used is "Saddlery, officers," "Saddlery, universal." Full details of the components of the various sets as used for R.E. units are given in tabular form in an appendix to each, A.F. G.1098.

(*b*). *Stable Necessaries.*—These comprise nosebags, brushes, rubbers and sponges (one set per horse), and buckets, water, canvas, one for two horses.

(*c*). *Forage.*—The scale of forage is laid down in *War Establishments*, 1907, Table IV., Section II. One day's ration of corn per horse (12 lbs.) is carried in regimental transport. One bale (82 lbs.) of compressed forage is carried in the locker of each G.S. or G.S. R.E. wagon. It is assumed that hay is available in the country.

(*d*). *Horseshoes.*—These are issued in sets of four shoes, with 60 nails per set. The allowance is one pair per shoe case, carried on the horses, and spare sets to the number of 15 per cent. of the establishment of horses, carried in vehicles.

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3. VEHICLES.

The changes in patterns and details of vehicles have been numerous and important since the South African War. Nearly every pattern has been reconsidered.

(*a*). *Vehicles and Components.* — The following changes affect practically all existing vehicles :—

(1). *Pole draught* has been substituted for shafts in all cases except the balloon wagon and cable cart. This change has been made in both old and new patterns.

(2). *South African brakes* will be fitted to all vehicles except carts, tool, R.E., Mark II. ; wagons, balloon, boat, cable, light spring, R.E. At present this change has only been effected in air-line, pontoon, and reservoir gas wagons on charge of units, and in new supplies of all patterns.

(3). The patterns of *axles* and *wheels* have been standardized, to reduce the number of different kinds in the Service.

Future patterns of R.E. vehicles will have mainly No. 165 fore axle and No. 199 hind axle, with Nos. 150 and 200 wheels. This change has been only applied to new supplies.

The following patterns of vehicles have been rendered obsolete for the reasons stated :—

(1). *Wagon, Tool, Field Troop, R.E., with Limber.*—Replaced by cart, tool, double (see L. of C., §13,763).

(2). *Wagon, Forge, R.E.*—This was a G.S. R.E. wagon, with special fittings for a forge and vice. These latter are now treated as separate stores, which can be carried in any vehicle. The forge wagon has been converted to G.S. R.E. (see L. of C., §13,420).

(3). *Lithograph Wagon.*—Abolished, as litho stores are now carried in cases or chests, which can be transported in a forage cart or other vehicle. This wagon will shortly be declared obsolete in L. of C.

Some new vehicles have been introduced, and there are now the following R.E. vehicles in the Service :—

(1). *Cart, Tool, R.E.*—A new pattern of this cart has been introduced, called Mark II., with a box body and other improvements, which will shortly be detailed in L. of C. The distinction between front and rear carts is abolished. Each cart is a separate item for store purposes. Two carts limbered up to form one vehicle are called a "double tool cart." Certain straps, to hold a few tools likely to be required on the line of march, are fixed on the outside, and can be used at the discretion of the officer in charge. Mark I. carts are being converted by the substitution of a body for the detachable tool boxes now carried. Both Marks are fitted for pole draught ; the Mark I. has the South African pattern of brake, the Mark II. rear arm brake.

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(2). *Cart, Cable.*—This cart is being superseded by a cable wagon on the limber principle (see L. of C., §13,770); it is fitted for shaft draught.

(3). *Wagon, Air-Line.*—Minor alterations have been made in this wagon, mainly by the use of pole draught and South African brakes (see L. of C., §12,463, 13,455, and 13,731).

(4). *Wagon, Balloon.*—This is a G.S. R.E. wagon, fitted with winding gear for controlling the balloon. It will probably be replaced by a new wagon on the limber principle. It has shaft draught.

(5). *Wagon, G.S. R.E.*—This wagon, which was formerly used by all R.E. units, is now retained only for use by telegraph units, whose instruments must be carried in a vehicle with springs. In other units it will eventually be replaced by wagons G.S. Mark VIII. or later patterns. For the present, to use up stock, several units retain G.S. R.E. wagons. G.S. R.E. wagons, having springs, give an easier draught than the springless G.S. wagons, but have a tare load of 5 cwt. in excess of the latter. Wagons G.S. R.E. have pole draught and South African brakes.

(6). *Wagon, Printing.*—This is retained for use with the printing equipment in the field. Some alterations of pattern are being considered.

(7). *Wagon, Pontoon.*—Numerous minor improvements, based on South African experience, have been introduced into this vehicle. The width of track has been reduced from 5 ft. 10 ins. to 5 ft. 6 ins., to bring this vehicle more into line with other vehicles. It has pole draught and South African brakes.

(8). *Wagon, Reservoir, Gas.*—This is retained to carry tubes of hydrogen gas for balloon units. It has been strengthened by the substitution of the fore carriage of the G.S. R.E. wagon for the old fore carriage. It has pole draught and South African brakes.

The following are new vehicles:—

(9). *Wagon, Cable.*—This has superseded the cable cart. It is on the limber principle. The body carries eight miles of field cable on four drums, and is fitted with winding-up gear and seats for two men of the detachment. The limber is fitted with a complete third-class office set (vibrator and telephone receiver), and there is also space for a few tools and stores. It has pole draught and front arm brakes (see L. of C., §13,770).

(10). *Wagon, Light Spring.*—This has been introduced mainly for use by telegraph units to carry small loads or detachments in attendance on cable wagons. It will carry 1,500 lbs. load, or 10 men for short distances. It is of especially light construction, with four wheels, pole draught, and front lever brake (see L. of C., §13,256).

(11). *Wagon, Boat.*—This has been introduced to carry a collapsible boat equipment with field troops. It will take two boats

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and superstructure for one raft. It has pole draught and front lever brakes (see L. of C., §13,383).

(12). *Wagon, Ambulance.*—Some Mark V. wagons of this type are being converted for transporting the men of field troops. The new nomenclature is not yet settled. They can carry 10 men each, with small stores or tools. They have pole draught and brakes of the lever type.

(13). *Wagon, Wireless Telegraphy.*—Is being designed on the limber principle to carry one complete set of instruments with aerial. The body will contain the machinery for the electrical power, the limber the receiving and sending instruments.

(14). Special vehicles for field search lights have been designed, but this equipment is still only in the experimental stage. In addition to the special R.E. vehicles, the following army vehicles are included in R.E. equipment :—

(15). *Cart Forage.*—Two-wheeled, shaft draught, South African brake. Used for carriage of tools, stores, or supplies, and for many purposes in camp and on the march.

(16). *Cart, Maltese.*—Two-wheeled, shaft draught, South African brake, with springs. Used for medical instruments and supplies.

(17). *Cart, Water.*—These are supplied and driven by A.S.C. The latest mark is of the tank pattern, carrying 118 gallons of water, and is being fitted with a filtering apparatus, which includes a pump.

(18). *Wagon, G.S.*—This is the ordinary type of four-wheeled wagon used throughout the Service. It has pole draught and no springs. The patterns of brakes are :—Mark VIII., front lever brake ; Mark VIII.*, front lever brake coupled with screw at rear ; Mark VIII.**, front lever brake with independent S.A. brake ; later patterns, S.A. brake combined with front lever brake.

(19). *Wagon, Limbered G.S.*—This is a small vehicle of limber type, recently introduced for the carriage of S.A. ammunition and tools, but has not yet been included in R.E. equipment. A Table is attached, giving the most important details of the above vehicles.

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TABLE GIVING DETAILS OF VEHICLES USED IN R.E. EQUIPMENT.

Vehicles.	Pattern of Pole	Pattern of Shaft.	Pattern of Axletrees.	Pattern of Wheels	Pattern of Brake.	Weight. Stripped.	Weight. Complete, with Spare Parts, Accessories, & Vehicle Equipment.	Width. Over-all.	Width. Of Track.	Length, Over-all (including Pole or Shaft except where otherwise stated).	Remarks.
						lbs.	lbs.	′ ″	′ ″	′ ″	
Carts, Cable :—											
Mark I....	—	Nos. 67 & 68	3rd Cl. B, No. 166	3rd Cl. B, No. 146	S.A.	1176	1194	6 0	5 2	13 10	(*a*). Including outrigger.
,, II.	—					1325	1343			15 0	(*b*). With pole extended.
Carts, Forage :—											(*c*). With pole used as a perch.
Mark I.	—	Nos. 43 & 44	3rd Cl. B, No. 157	3rd Cl. B, No. 158	—	910	953	6 3 (*a*)	5 2	15 6	(*d*). With 2nd Class hind wheels
,, II....	—				S.A.	938	981				(*e*). With 3rd Class hind wheels.
Carts, Maltese :—											(*f*). With pole.
Mark II.	—	Nos. 63 & 64	3rd Cl. A, No. 146	3rd Cl. B, No. 158	—	728	805	6 1	5 2	13 1	(*g*) Without pole.
,, III.	—		3rd Cl. B, No. 157		—						
,, IV.	—				—						
,, V.	—				S.A.	763	840			13 5	
,, V.*	—										
Carts, Tool, R.E :—											
Mark I.	Draught No. 14	—	3rd Cl. B, No. 176, Mk. II.	3rd Cl. B, No. 144	S.A.	1134†	1168	6 0	5 2	15 1 (*b*)	
,, II.	,, No. 20	—	2nd Cl. C, No. 200	2nd ,, C, ,, 200	Rear arm brake	1120†	1146	6 2		8 10 (*c*)	
										16 0 (*b*)	
										10 9 (*c*)	
Carts, Water Tank :—											
Mark I.	—	Nos. 63 & 64	3rd Cl. B, No. 157	3rd Cl. B, No. 158	—	1054	1072	6 1	5 2	—	
,, I.*	—				S.A.						
,, II.	—				S.A.	1025	1043				
Wagons, Air-Line :—											
Mark I. (*d*)	Draught No. 7A.	—	3rd Cl B, No. 165 (fore)	3rd Cl. B, No. 150 (fore)	—	2352	2382	6 2	5 2	25 4½	
			2nd ,, C, ,, 199 (hind)	2nd ,, C, ,, 200 (hind)							
,, I. (*e*)		—	3rd ,, B, ,, 165 (fore)	3rd ,, B, ,, 150 (fore)	—			6 1			
			3rd ,, B, ,, 166 (hind)	3rd ,, B, ,, 145 (hind)							
,, II.		—	3rd ,, B, ,, 165 (fore)	3rd ,, B, ,, 150 (fore)	S.A.			6 2			
			2nd ,, C, ,, 199 (hind)	2nd ,, C, ,, 200 (hind)							
Wagon, Balloon, R.E. .	—	No. 100	3rd Cl. B, No. 165 (fore)	3rd Cl. B, No 150 (fore)	—	2653	2793	6 2	5 2	21 9	
			2nd ,, C, ,, 199 (hind)	2nd ,, C, ,, 200 (hind)							
Wagon, Boat	Draught No. 7A	—	3rd Cl. B, No. 177 (fore)	3rd Cl. B, No. 150 (fore)	Front lever br'ke	1736	1766	6 2⅝	5 3	21 2	
			2nd ,, C, ,, 199 (hind)	2nd ,, C, ,, 200 (hind)							
Wagon, Cable :—											
Limber	Draught No 17, Mark III.	—	2nd Cl. C, No. 198	2nd Cl. C, No. 200	Front arm brake	924	2055	6 2½	—	13 10 (*f*)	
Body		—	,, ,, C, ,, 38			1106				5 3 (*g*)	
Limber and body ...		—	—	—	—	2030		6 2	5 3	11 8	
										24 7¾ (*f*)	
										16 1 (*g*)	

† Single Carts.

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Vehicles.	Pattern of Pole.	Pattern of Shaft.	Pattern of Axletree.	Pattern of Wheels.	Pattern of Brake.	Weight. Stripped.	Weight. Complete, with Spare Parts, Accessories, & Vehicle Equipment.	Width. Over-all.	Width. Of Track.	Length Over-all (including Pole or Shaft except where otherwise stated).	Remarks.
						lbs.	lbs.	′ ″	′ ″	′ ″	
Wagons, G.S. :—											
Mark VIII.	Draught No. 7A.	—	3rd Cl. B, No. 159 (fore)	3rd Cl. B, No. 159 (fore)	Front lever brake	1792	1909	6 2	5 2	22 8	(*d*) With 2nd Class hind wheels.
,, VIII.*		—			Front lever br'ke coupled with screw at rear	1904	2021				(*e*). With 3rd Class hind wheels.
,, VIII.**		—		2nd ,, C, ,, 200 (hind)	Front lever br'ke with independent S.A. brake	1954	2071				
,, IX.		—	2nd Cl. C, No. 200 (hind)		S.A. brake combined with front lever brake	1848	1965				
,, X.		—				1792	1909			23 0	
,, X*		—		3rd Cl. B, No. 159A (fore) and ,, C, ,, 200A (hind)		1792	1911	6 4			
Wagons, G.S , R.E. :—											
Mark I. (*d*)	Draught No. 7A.	—	3rd Cl. B, No. 165 (fore) 2nd ,, C, ,, 199 (hind)	3rd Cl. B, No. 150 (fore) 2nd ,, C, ,, 200 (hind)	—	2464	2604	6 2	5 2	20 8	
,, I. (*e*)		—	3rd ,, B, ,, 165 (fore 3rd ,, B, ,, 166 (hind)	3rd ,, B, ,, 150 (fore) 3rd ,, B, ,, 145 (hind)				6 1			
,, II.		—	3rd ,, B, ,, 165 (fore) 2nd ,, C, ,, 199 (hind)	3rd ,, B, ,, 150 (fore) 2nd ,, C, ,, 200 (hind)	S.A. brake			6 2		21 9	
Wagon, Light Spring, R.E.	Draught No. 8	—	3rd Cl. B, No. 215 (fore) 2nd ,, C, ,, 200 (hind)	3rd Cl. B, No. 143 (fore) 2nd ,, C, ,, 199 (hind)	Front lever br'ke	1064	1120	6 2½	5 2	19 10	
Wagons, Pontoon :—											
Mark IV.	Draught No. 7A.	—	3rd Cl. B, No. 167 (fore)	3rd Cl. B, No. 150 (fore)	S.A. brake	2100	2129	6 10½	5 10	26 4½	
,, IV.*		—	2nd ,, C, ,, 88 (hind)	2nd ,, C, ,, 200 (hind)				6 7	5 6½		
Wagon :—											
Lithograph, Mark II.	Draught No. 7A	—	3rd Cl. B, No. 165 (fore) 2nd ,, C, ,, 199 (hind)	3rd Cl. B, No. 150 (fore 2nd ,, C, ,, 200 (hind)	S.A. brake	—	—	6 2	5 2	21 9	Obsolete.
Wagon, Printing ...	Draught No. 7A	—	3rd Cl. B, No. 165 (fore) 2nd ,, C, ,, 199 (hind)	3rd Cl. B, No. 150 (fore) 2nd ,, C, ,, 200 (hind)	S.A. brake	2800	2830	6 2	5 2	21 9	
Wagon, Reservoir, Gas :											
Mark I....	Draught No. 7A	—	3rd Cl. B, No. 51B (fore)	3rd Cl. B, No. 150 (fore)	S.A. brake	1820	1850	6 0	5 2	20 8½	
,, II.		—	2nd ,, C, ,, 45 (hind)	2nd ,, C, ,, 200 (hind)							
Wagon, Limbered, G.S :											
Fore, Mark I ...	Draught No. 17, Mark III.	—	2nd Cl. C, No. 141	2nd Cl. C, No. 198	—	616	1297	6 4	5 2	13 11 with pole. 4 10 without pole.	Length over all limbered up :—
Hind, ,, I....		—	,, ,, ,,	,, ,, ,,	S.A. brake	588				9 1 with perch. 5 4 without perch.	22 10 with pole. 13 9 without pole.

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(*b*). *Wagon Equipment and Spare Parts.*—The components of each vehicle, with a list of accessories, spare parts, and wagon equipment, are shown in Army Form G.1096. The components form part of the vehicle for store purposes, but accessories, spare parts, and wagon equipment are held on separate charge.

The wagon equipment of ordinary vehicles includes a few tools—such as pickaxe, shovel, and hammer—so as to make a convoy of wagons self-contained as regards camp duties or small casualties on the line of march. Such tools always remain with the vehicles, and are not available for other purposes.

For ordinary transport vehicles this arrangement is convenient, but for technical vehicles, which carry tools for their technical duties, the arrangement is not convenient, so the cart or wagon equipment of R.E. vehicles now only includes such articles as buckets, or inventory boards, which are always with the vehicles. Any tools required for camping, etc., will be taken from the general equipment of the unit. The accessories are mainly such articles as covers and seats.

The spare parts now carried by each vehicle are reduced to a few spare pins and washers. The amount of spare parts, carried in the field, as wheels, axles, and poles, has been much reduced on the understanding that the general army organization will arrange for periodical issue of such parts by the A.O.D. Spare poles in the proportion of 25 per cent. of the vehicles are included in the equipment of most units.

4. MEDICAL AND VETERINARY STORES.

Medical officers are no longer attached to each R.E. unit, but are distributed as under :—

One with headquarters of divisional Engineers.

One with each bridging train.

Each medical officer is accompanied by a Maltese cart, driven by one of his orderlies. The cart and harness are included in the equipment of the above units. The medical equipment, consisting of one medical companion, one surgical haversack, two field panniers, is brought to the place of mobilization by the medical officer. A similar arrangement is made for veterinary duties, except that the veterinary equipment of one 84-lb. and two 25-lb. chests is carried on a pack animal.

In addition certain 25-lb. chests or wallets of veterinary stores are carried as under :—

	25-lb. Chests.	Wallets.
Balloon companies	—	1
Bridging trains	—	2
Cable telegraph companies	1	4
Wireless „ „	—	1
Air-line „ „	2	4
Field troops	1	1
Field companies	1	2

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5. GENERAL TOOLS AND MATERIALS.

(*a*). *Saddlers' Tools* are issued in filled holdalls, weighing 13¼ lbs. One or two of these are issued to units, according to size. A small quantity of suitable materials for repair of harness is carried by each unit, except divisional telegraph companies and headquarters of divisional Engineers.

(*b*). *Farriers' Tools* are issued in filled tool bags, weighing 14½ lbs. each. They are issued one to each section and one to the headquarters of each unit.

(*c*). *Shoemakers' Tools and Materials* are carried in a filled bag, weighing 25 lbs. One or two bags are issued to each unit, according to size.

6. TOOLS FOR MILITARY PURPOSES.

The numbers of these carried by each R.E. unit necessarily varies with the probable work to be done and with the details of packing. This is best considered when discussing the equipment of each class of unit.

The following is approximately the proportion of tools of this class carried by a field company, and may be useful as a guide when making up improvised equipments. It is, of course, intended for an ordinary European cultivated country, with a due proportion of trenching and cutting. For each 20 non-commissioned officers and men (dismounted branch) allow :—

Shovels, R.E.	12	Hand axes	3
Pickaxes (9 with 4½-lb. heads and 3 with 8-lb. heads)	12	Billhooks	4
Spades	2	Handsaws	3
Felling axes	4	Crowbars (4 ft. 6 in.)	1

The pattern of shovel and pickaxe carried by R.E. has been much discussed; the latest pattern of shovel is special to R.E. and weighs 5 lbs. 2 ozs. The pickaxe for general use has a 4½-lb. head with the helve shod with a metal sheave, making the total weight of metal 5½ lbs. To provide for heavy work 25 per cent. of the pickaxes carried by field companies, and also those carried in pontoon wagons, have an 8-lb. head with an unshod helve.

7. R.E. ARTIFICERS' TOOLS.

The tools actually carried in the field have been reduced to the lowest possible amount. If a force remains stationary for any time and much R.E. work has to be done additional tools must be drawn from the A.O.D. or obtained locally. For details see the notes on organization of reserves.

The sets of tools in filled chests include many articles which are not essential for active service. Special sets applicable to field

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service have been selected, and are shown in detail in Army Form G.1098.

Tool chests are only carried in a few units. In other cases the tools are packed in Clarkson's chests, which are also available for pack transport, in leather holdalls (holdall, tool artificers, L. of C. §4,916), in bags, carpenters', or in sandbags.

The forges carried are :—

Forge, pack saddle for field troops and bridging trains.
„ double bellows for field companies.

But it is probable that the forge, field, G.S., which can be carried on a pack saddle, will supersede the above. A very small amount of fuel for forges is carried, and must be supplemented by local supplies.

Grindstones are required not only for artificers' but for other cutting tools. The present sizes are 10-inch and 18-inch (measuring by the diameter of the stone), but an intermediate size of 14-inch is being introduced for field companies and bridging trains, in lieu of the 10-inch, which is rather too light.

8. MATERIALS.

The amount of materials carried has been limited to that absolutely required for small repairs to equipment and vehicles. It must be supplemented by supplies obtained locally or from the A.O.D.

9. BLOCKS AND CORDAGE.

After some years of discussion and experiment the old patterns of wooden blocks have been superseded by a series made of malleable steel (see L. of C., 13,716). Each block is identified by the size of cordage with which it is used and the number of sheaves. The usual sizes carried are the single and double for 1½-inch or 2½-inch cordage.

White hemp cordage being stronger and more pliable than tarred, the former is included in equipment for all tackles. Tarred cordage is carried for certain bridging services and other special uses. Breast lines and cables, etc., for bridging services are issued in bulk as cordage, and cut to the required lengths when taken into use.

10. STORES FOR WATER SUPPLY.

For field use, a pump (lift and force, to lift 60 feet) with hose is carried on each tool cart of the field troops and field companies. For each pump there is carried in 2nd line transport a 600-gallon waterproof trough, with pickets and the necessary cordage. (*Military Engineering*, Part V., Miscellaneous, *Fig.* 3, *Plate* XXII.).

In addition to above, some water carts are being fitted with a filter apparatus, which includes a pump in its components.

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11. EXPLOSIVES.

The patterns of guncotton hitherto used in the field have been unnecessarily complicated.

R.E. units at present carry the T slab of wet guncotton (1½-lb.) with both F (2-oz.) and H (1-oz.) primers.

Cavalry carry the V slab (14-oz.) and the F primer, each slab being enclosed in a special tin case.

There are also varieties of packages and cylinders, and there is the further complication that the official weight of wet guncotton is the weight of the guncotton when dry, that is before any water is added.

It is intended in future to limit the guncotton carried in the field by all units to one pattern of slab and one pattern of primer. The slab will be a modified V, 15 ozs. in weight, $6'' \times 3'' \times 1\frac{3}{8}''$, with one perforation for primer. The primer will be a modified H, 1 oz. in weight. Both primer and perforation in the slab will be slightly coned, so that the primer when pressed home will fit tightly. The slab and primer together will thus weigh 1 lb., so that the number of slabs will in practice be the number of pounds in the charge.

Wet guncotton will be held on charge by slabs, instead of by weight. The wet guncotton for R.E. units and general service will be carried in the field in "boxes, guncotton, wet, field," to hold 14 slabs, but cavalry will retain their special tin cases for one slab. The dry guncotton will be carried in cylinders to hold 10 primers, the top being closed with a bayonet joint. Six cylinders are issued in a wooden case.

For firing charges R.E. units carry both electrical and ignition appliances.

The electrical appliances include a magneto generator, lengths of D 15 cable, and detonators No. 13.

The ignition appliances are No. 9 safety fuze, Vesuvian matches, and detonators No. 8. The matches and detonators are carried in special tin boxes.

Instantaneous fuze is not carried in the equipment, as it is mainly useful for firing charges simultaneously, or for mines or long bore holes, for all of which the electrical gear can be used.

12. SIGNALLING STORES.

A small signalling equipment of helios, lamps, and flags is carried by each field company; other units carry flags only.

13. SURVEY STORES.

Small sets of the usual military sketching and drawing instruments are carried in all units except telegraph units.

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14. SPECIAL TECHNICAL TOOLS AND STORES.

These will be dealt with when discussing the details of each class of unit.

15. MISCELLANEOUS.

(*a*). *Office Books.*

(*b*). *Stationery.*—Each unit carries one box stationery, field, filled. Units which exist in peace hold the boxes on peace charge, and for units which do not exist in peace the boxes are included in the mobilization equipment of the unit. The details of the contents are shown in the tables of books, army forms, and stationery issued with A.O. dated December, 1899, but this list now requires amendment as regards R.E. units.

(*c*). *Packages.*—The packages used for carriage of tools and materials have been already referred to. Where no special holdall or case is provided, tools must be packed direct into vehicles, sandbags or similar articles being used as packing.

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IMPERIAL DEFENCE.

By LIEUT. W. G. S. DOBBIE, R.E.

WITH reference to Major Harrison's article in the February number of the *R.E. Journal*, entitled "Military and Naval Home Defence," there seems to be another aspect of the case which has not been touched upon.

One of the chief dogmas of the Blue Water School is, that invasion is impossible so long as we maintain the command of the sea. The word "invasion" is taken to mean the landing of a force large enough to maintain itself in our country, and does not refer to raids by comparatively small bodies of troops; in fact, to land an "invading" army will take a very considerable time, even supposing the enemy is free of interruption both from the weather and any force we may be able to bring against him.

As to the exact length of time the enemy will be likely to have free from interference by our fleet, it is not possible to speak with any certainty; but it seems difficult to imagine that more than three days, at the very outside, could elapse before our fleets are on the spot in sufficient strength to overwhelm the invading ships. The Channel Fleet never cruises very far, and the Home Fleet, which, though a heterogeneous collection of ships, comprises a good many very powerful units, could easily mobilize in less than the time mentioned. In the three days it would not be possible to transport and land any force larger than 20,000 men, a number far too small for any effective operations in a hostile country. Further, this raiding force would know that it could not possibly return whence it came, as its retreat would very speedily be cut off by our fleet, a thought which would hardly be conducive to the peace of mind of the members comprising it. It would, therefore, seem that it is necessary for the British fleet to be placed *hors de combat* before a force, sufficiently large to invade England, could be landed on her shores. The next point for consideration is what would happen supposing we did lose command of the sea. This would certainly give our enemies the chance of invading our land if they wanted to. But it is very doubtful if they would do so, for the simple reason that there would be no necessity should the English fleet cease to exist.

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The people of England are almost entirely dependent for their food on that which is brought into the country from our oversea possessions or from foreign countries. The same applies, though in a lesser degree, to raw materials. If, then, we lose command of the sea, it would be no difficult matter for the enemy's ships to stop this supply of food from reaching our coasts. The end would not be long delayed. We would have to accept whatever terms were offered. To sum up the foregoing remarks, invasion is impossible so long as we retain command of the sea ; but if we lose that, invasion is unnecessary. It will then be asked—what is the object of having an army ? The answer is twofold—1st, to take the offensive, and so to bring our enemy to his knees ; 2nd, to protect our colonies which have a land frontier.

As regards the first, it will not be sufficient to keep the enemy's fleet blockaded in his ports. We cannot bring him to terms until we land an army in his territory, and so render it impossible for him to ignore our demands. It is not suggested that it would be possible to land an army, say in France or Germany, large enough to take Paris or Berlin, but we could invade and overrun the enemy's colonial possessions, a plan of operation which would in time produce the desired result.

Conversely our colonies would be a very convenient object of attack if they happened to adjoin the territories of our enemies. The most striking examples of this are Canada and India. To protect these possessions a large number of troops will be required. In the case of India they already exist, but in Canada the number of troops now available is totally inadequate in view of the immense length of frontier to be protected. Nor does its population admit of sufficient expansion of its peace army without interfering with its industries. It is here that a considerable portion of the regular army could with great advantage be stationed, thus strengthening what would otherwise be a very weak point in the defence of the Empire.

The troops at home would then consist of :—

(*a*). Garrisons of our big naval ports.

(*b*). The striking force.

The regular troops might be supplemented by a well-trained militia, which would make good the wastage of a campaign ; but no reliance must be placed on this or any other military force to resist invasion. That is a duty that the Navy, and the Navy alone, must perform.

As regards the protection of our commerce, the fact that the bulk of our armoured ships are in home waters does not really constitute a danger, as these ships would not be used for commerce protection. No enemy would dare to detach any of his armoured ships for the

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purpose of raiding our commerce. It would, therefore, follow that armoured ships are not required for its protection, but protected cruisers, which have the advantage of being cheap, and therefore numerous. If the enemy's fleet is blockaded efficiently, there is theoretically no need for commerce protection at all. It is only because some of the enemy's ships may slip through the blockading force that the necessity for commerce protection arises.

To sum up:—For the reasons given above the Navy should be considered the defensive weapon, and the Army the offensive. It is a waste of time and money to try and make the Army do the Navy's work, and it is equally impossible for the Navy to do that of the Army.

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MILITARY v. NAVAL HOME DEFENCE.

By COLONEL E. H. BETHELL, D.S.O., *p.s.c.*, LATE R.E.

IN the February number of the *R.E. Journal* Major W. A. Harrison raises some important points and makes some important assumptions.

I venture to consider the former and to make some criticisms on the latter.

Major Harrison assumes that in the very early stages of a war, and before the naval forces engaged have had time to establish a superiority on one side or the other, an invasion on a large scale may be launched against us; he considers that some foreign complication, such as the recent Turkish move towards Egypt, might draw away so much of the strength of our available squadrons to distant waters as to make it possible for an enemy to obtain temporary command—say for six clear days—of the waters over which the invading force was to be thrown.

Having made this assumption, Major Harrison proceeds to base upon it an argument concerning our military forces; he says that admittedly our Territorial Force will not be fit to meet a properly trained enemy during the first months of war, and that therefore it can only be auxiliary to our home defence army; that the latter must be raised to the number required for home defence under every condition, irrespectively of the Territorial Forces; but that it may "include the striking force, which is apparently considered of such primary importance."

I think such a scheme of the requirements of a home defence army, irrespective of the Territorial Forces, is for all practical purposes an impossible scheme; Major Harrison's hostile transports are going to have six clear days of transporting troops, and, therefore, an invasion on a large scale is evidently intended, when the large quantity of shipping available, *e.g.*, in Germany, is considered. I suppose that with the three clear days of preparation Major Harrison will expect the enemy to get *at least* five army corps, say 150,000 men, across; perhaps, having regard to the enclosed nature of the country to be traversed, these corps would not be of normal composition—they might contain an abnormal proportion of infantry, and total up to 200,000 men.

This being so, his home defence army, "irrespective of the Territorial army," will, I suppose, consist of at least 200,000 men, with a due proportion of all arms.

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The country is to pay for a two-power standard fleet, a regular colonial army, a territorial army, and finally for this large home defence army.

Proceeding to criticize this programme, I would observe that it seems to me very unlikely that in the very early stages of a war, before the respective naval forces had found their level or taken each other's measure, and while our striking force was still at home, such an invasion would be projected; if, however, there were a reasonable probability of such an attempt, then the obvious reply would surely be better training of the territorial army.

In any solid programme of defence industrial conditions cannot be ignored; war has got to be one function of a nation's organic whole, and preparation for it must not make impossible its other and equally necessary functions.

Consistently with this condition I think we cannot hope for more, and we ought not to be content with less than a territorial army trained approximately on the Swiss model; our streak of silver sea still gives us, in all human probability, time for preparation; if Germany is able to launch half a million men within a week against France, then France must be able to mobilize about the same number in the same time. In our case it is unlikely that, at any rate, under present naval conditions, we shall be invaded by even 150,000 men within a week of a declaration of war; our striking force is sure to be at home in the early stage of a war; it behoves us so to organize, equip, and train our territorial army that we may be able to mobilize it at once, and proceed without delay to more thorough training than we have been able to give it in peace time.

Whether such a standard can ever be attained on any other basis than that of universal training and liability to serve may well be doubted, in spite of the experiment now being made. What additional motives are we bringing to bear on our wished-for recruits to the Territorial army other than those which have always operated on Volunteers? County rivalry—nothing else tangible. The essentially defective justice of any scheme, which is intended to saddle the patriotic part of the community with the sole liability to duties which are more and more recognized to be incumbent on all young men who exercise the rights of citizenship, must, I believe, in the long run make every such scheme comparatively unfruitful.

The Chancellor of the Exchequer would indeed be in an evil plight if he were compelled to rely for the collection of taxes on considerations similar to those so eloquently brought forward by the Secretary of State for War, with a view to induce recruits to join.

Having, however, got our territorial army, it seems to me that the further question of the extent to which permanent fortification should be called in to strengthen the coast defence of the country is one which can only be settled by considering each individual case, bearing

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in mind that permanent fortifications are immovable, and may never be used, while the force of armed men can be concentrated and used where it is wanted.

I think a few "staff rides," dealing with coast-defence problems, show one how great the resources of defence are in many parts of our coasts, and how greatly they are increased by full consideration beforehand.

Finally, I suppose, from Major Harrison's expression "the striking force, which is apparently considered of such primary importance," that Major Harrison does not consider it is of primary importance. To me it seems vital and primary in the highest degree. The idea that in these days, when war means the subordination of every other function of a nation during war to the requirements of war, when it means the concentration of national energy on war, 44 millions of people are to take no part in it, leaving everything to be settled by its comparatively few sailors, is not, I think, tenable.

There is a limit to the damage that fleets can do; moreover, it is certain that we cannot hope to survive without alliances, and it is certain that some promising alliances with us will lose much of their value to our ally, if that ally doubts our will and ability to despatch an army to its assistance—an army of which sea power will double the value—when required.

Therefore, a powerful striking force we must have, and what is more, a reserve of trained men sufficient to enable it to keep the field in modern war.

Who shall say that Lord Roberts's million of trained and partly trained men is an excessive estimate for all purposes; or who will maintain that such a reservoir of trained men can be obtained without ruining the country by any other means than the means adopted by every country which has had to consider the situation practically, viz., by universal service of some kind?

There is the comparatively expensive kind which circumstances have forced on Germany and France, with its comparatively protracted training—and there is the cheaper kind, which is good enough for Switzerland, which has only to make its neutrality respected, and which is probably good enough for us, who have the advantage of time for preparation, and who have to pay for a two-power standard fleet and a colonial army.

Certainly, Germany seems to have solved the combined military and industrial problem in a way which smashes the croaking critics of 25 years ago; for she has got the army she wants, and yet with a birth rate 50% greater than ours, and an emigration which is a small fraction of ours, her industrial position is very strong.

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REPORT ON AN IMPROVISED SEARCH LIGHT ON BOARD THE R.I.M.S. "MINTO."

By MAJOR W. P. BRETT, R.E.

General Conditions.—During the 1907 manœuvres in Aden, an experiment was made to see whether field search lights could be improvised from material available at the station, but the difficulties of obtaining proper generating plant were too great to allow of their being fitted up in time of peace. The General Officer Commanding, therefore, gave orders to fit up a search light on board the R.I.M.S. *Minto*, which was at the time at Aden, and she was then moored in such a position that the search light could be used with effect.

Projector, Construction of, etc.—No projector was available, but there was the base (complete) of a Mark III. projector in store. The remainder had to be constructed in the workshops, and, as time was of great importance, it was made as light as possible. *Fig.* 1 shows the general construction of the projector.

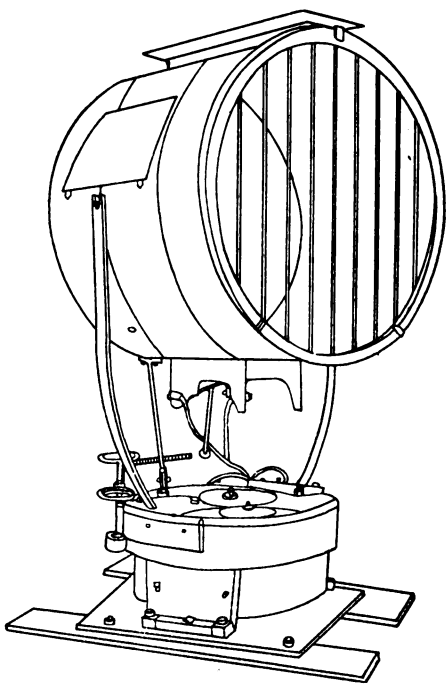

FIG. 1.

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A palladium reflector without its case was used, as being the most convenient.

Ten round iron rods, $\frac{5}{8}$ inch in diameter, were then bolted to the mirror, as shown in *Fig.* 2, and a ring of flat iron was bolted to the other ends of the rods. This completed the frame.

The frame was stiffened by binding the rods together, near their middle, with stout iron wire (see *Fig.* 2).

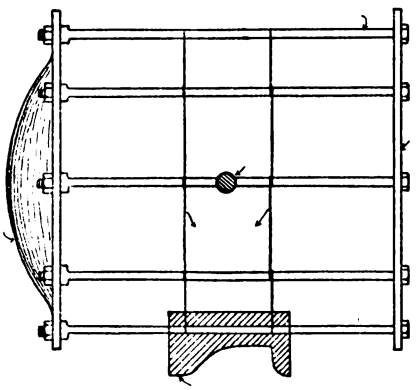

FIG. 2.

Lamp.—A hand lamp was used with an adapter, the adapter being fixed to the two lower rods in a position to allow of the arc being central to the reflector. The adapter also allowed the lamp to be adjusted backwards, or forwards, for focus.

Trunnions.—The trunnions were formed by two pieces of iron, made in the form of an ordinary lathe carrier, thus being adjustable backwards or forwards, their position being fixed by trial before the outer case was fixed on (see *Fig.* 3).

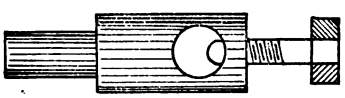

FIG. 3.

Outer Case, etc.—The outer case was made of sheet iron, obtained from empty kerosene tins. Each tin, when cut, makes a strip about 1 foot wide and $3\frac{1}{2}$ feet long. These strips were placed round the frame, and bound to the rods and to each other with iron wire. An inspection door at each side and a ventilator at the top were made of the same material.

A glass door, at the front of the projector, was made with a framework of wood, and fixed on by iron clips.

The legs were formed of two heavy pieces of flat iron bolted to the base.

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Elevation and depression were worked by means of a long screw, with wooden hand wheel, working in a nut fixed to the back of the projector.

Plant on the "Minto."—On board the R.I.M.S. *Minto* were two dynamos, driven by vertical steam engines, each of which was capable of 100 ampères, at 100 volts pressure.

Special arrangements were, therefore, necessary to reduce the voltage, and to guard against too great a current being taken by the lamps on closing carbons.

Fig. 4 shows the connections and resistances used.

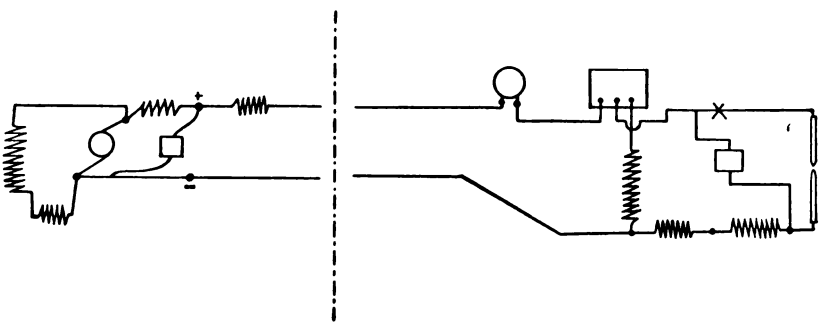

FIG. 4.

Three ohms in adjustable resistance, reduced volts at dynamo to 80. Volts at lamp were 50, and current 75 ampères.

After a trial run, it was found that only one of the ·25 ohm resistances was required.

The running of the lamp was very satisfactory in every way; no hitch occurred.

The R.E. engine drivers and electricians took charge of, and ran all the machinery.

To test the efficiency of the beam, a company of the 2nd Battalion Suffolk Regiment advanced over some broken ground within range of the beam.

The beam was found to be very efficient up to 800 yards. This is not so great as might have been expected, but, with a better reflector and a little more experience in handling the beam, better results would probably be obtained.

The General Officer Commanding expressed himself as satisfied with the results.

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R.E. CORPS LIBRARIES AND PUBLICATIONS.

By LIEUT.-COLONEL B. R. WARD, R.E.

NOTHING could more clearly indicate the intellectual awakening effected in the Corps by the Royal Engineer Establishment at Chatham, than the fact that a professional library was started within a year of the issue of Pasley's first order as director of the establishment.

The library was started at a general meeting of R.E. officers stationed at Chatham, held on the 3rd November, 1813. Colonel Robert D'Arcy, C.B., was president of the meeting, being, doubtless, the senior R.E. officer stationed at Chatham at the time.

During the next five years similar libraries were established at other stations both at home and abroad. "The object of such libraries," says Pasley, "is to enable officers of Engineers to study their profession in any part of the world to which they may be ordered, without the trouble and expense of moving private libraries, which would exceed the means of any individual. None but books of deserved reputation are admitted; and of the most useful works several copies are provided, in order that more than one subscriber may read such works at the same time. The expenses are entirely defrayed by a small monthly subscription of members present only, no entrance being charged."*

This library was kept in the office of the clerk of works at Chatham, a non-commissioned officer being employed as librarian, in addition to his other duties as assistant to the clerk of works. This librarian received, besides his ordinary pay, "one day's extra allowance in each week" from the officers who were members of the library.

Company libraries were soon afterwards started by Colonel Pasley. These libraries consisted of a few selected books of geometry, mechanics, or of a military nature likely to prove instructive to the N.C.O.'s and men. They were purchased by them by voluntary subscription, and were carried in a box when the company moved. "It is desired," writes Pasley, "that the captains of companies will patronize this measure if they should be requested so to do by the men under their command; but without using any influence to induce non-subscribers to come forward."†

* Pasley's *Standing Orders for the R.E. Establishment, 1818*, p. 259.
† Pasley's *Standing Orders*, p. 260.

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The first company library on this principle, was established by the 7th Company, 1st Battalion, early in 1816.

The Corps Library established at Chatham in 1813 is still in existence, but it is now generally known as the S.M.E. Library. It is managed by a committee of officers at the station, under the Commandant of the S.M.E.

The other libraries, with the exception of one started at Dublin in 1825, appear to have gradually died out, until the idea was resuscitated by Lieut.-Colonel R. C. Alderson in 1845. The present central Corps Library is situated at the Horse Guards, London.*

Branch libraries exist at most R.E. stations of any importance. Two of these—viz., those at Esquimalt, B.C., and at Halifax, N.S.—were handed over by the officers of the Royal Engineers to their successors, the Royal Canadian Engineers, in 1906, in which year the Dominion Government took over from the Imperial Government the duty of garrisoning these fortresses. These libraries will, it is hoped, form a visible link connecting the Royal Canadian Engineers, who were organized in 1903, with the parent Corps.

The R.E. Corps libraries have, since 1877, been managed by the R.E. Institute Committee.

The various R.E. Corps publications may be divided up under four heads :—

(1). S.M.E. text books.
(2). *R.E. Professional Papers.*
(3). The *R.E. Journal*—an officers' periodical.
(4). The *Sapper*—a rank and file paper.

S.M.E. Text Books.

Pasley's earliest text book, the *Course of Instruction in Practical Geometry*, was published by John Murray in 1814. The two succeeding volumes of the *Course* were published by the same house in 1817.

Pasley's *Exercise of the New Double Pontoons*, 1821, *Escalading*, 1821, and many other books of instruction, were, however, lithographed at the R.E. Establishment, Brompton Barracks ; and, from that day to the present time, nearly all the R.E. text books have been either lithographed or printed at the S.M.E. Although the *R.E. Professional Papers* were for the first thirty-eight years of their existence—from 1837 to 1875—published away from Chatham, since the latter date not only the *Professional Papers*, but also the *R.E. Journal* and the *Sapper*, have all been published at Chatham, and are all closely connected with the S.M.E.

Professional Papers.

Lieut. W. D. Denison started the *Professional Papers* in 1837, as mentioned by Major-General Harness, C.B., in a memoir he wrote on him in 1872. He writes : "In 1837, while a subaltern in the Corps, the officer to whom these passing tributes of respect and affection are

* For a history of the R.E. Corps libraries from 1845 see the preface to the *Catalogue of the London Library.*

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paid succeeded in establishing the *Professional Papers*, and in so doing has, with the single exception of the founder of our School at Chatham, done more to increase the interest of his brother officers in their profession, and to diffuse through the Corps the experience of its individual members, than any of his predecessors or contemporaries."*

In 1837 Lieut. Denison was quartered at Woolwich, at that time the headquarters of the Royal Sappers & Miners. He succeeded in interesting several of his brother officers in the question of publishing papers on professional subjects, pointing out the desirability of the publication of a professional work, in which should be embodied the experience of individuals. Such a work, he maintained, being circulated among the officers of the Corps at large, would serve, in some measure, to remedy the inconveniences which arise from their being scattered all over the world, and consequently unable to take advantage of that freedom of intercourse and interchange of information which would otherwise take place amongst them.†

A meeting of several officers was held, at the Royal Engineer Office, Woolwich, for the purpose of considering the details of a plan proposed by Lieut. Denison for the attainment of this object, and entirely concurred in the opinion expressed in the prospectus he laid before them. Resolutions were passed asking him to take charge of the proposed publication, and when these had been approved by the Inspector-General of Fortifications, Lieut. Denison at once entered upon his duties as editor.

In his introduction to the first volume, published by J. Barker, of Fleet Street, in 1837, Denison prefixed a few introductory remarks, in which he clearly set forth the object of the *Papers*, viz., to collect and arrange the large amount of professional information disseminated throughout the Corps, and to enable officers to benefit by the experience of all engaged in engineering work by combining it with that derived from other sources. Several attempts had already been made to start such papers, but had hitherto failed, and, as Denison pointed out, it was only by co-operation and by every individual contributing, that the experiment could be made to succeed. If this were not done, the existence of the *Papers* might indeed be prolonged for a few years, by drawing upon stores of knowledge that had already been accumulated; but when these were exhausted, the common routine duties of the Corps would hardly afford material for an annual volume. He added that the materials could be found both in the numerous experiments and investigations of subjects connected with both the military and civil branches of our profession, and also in the study and application of sciences which not only are both useful and interesting, but also tend to draw closer the bonds which

* *R.E. Professional Papers* for 1872, Vol. XX., New Series.
† *Professional Papers of the Corps of R.E.*, Vol. I., Preface, p. iii.

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unite us to other scientific bodies. Denison then points to the unfavourable way in which the military academies of this country compared, as places of scientific instruction, with those of other countries, and ends the introduction in the following words:— "Labour and study will be requisite to enable them (*i.e.*, young officers) to perform satisfactorily their ordinary duties, and this should be their first consideration; but this labour and study brings with it its own reward, not only as it enables them to perform their duties efficiently, but as it is the stepping stone to the cultivation of those sciences which open a wider range to the intellect, extend their sphere of usefulness, and which, by occupying the mind and improving the faculties, tend eventually to make them better officers and men."

Denison edited the first eight volumes of the *Professional Papers*, and on resigning the editorship, on his appointment to the Lieut.-Governorship of Tasmania, he was succeeded by Capt. Henry James, who edited the ninth volume.

In the preface of this volume, dated 8th March, 1847, Capt. James writes: "I feel assured that it will be gratifying to the Corps, and to the officers who have subscribed to the *Professional Papers*, to learn that. at the meeting which was held in September last, the officers there assembled voted as from themselves only (they were not authorized to represent the Corps in this matter) a piece of plate to Sir W. Denison, on which the following inscription was engraved:— "Presented by his brother officers who attended the meeting of the 23rd September, 1846, to Capt. Sir William Denison, Royal Engineers, as a token of grateful remembrance that to him alone they are indebted for having originated the diffusion of individual experience by means of *Professional Papers*, which he has continued to conduct for a period of 10 years, until he was appointed to the Government of Van Diemen's Land."

During the early seventies the inadequacy of the machinery for producing the *Professional Papers* appears to have begun to make itself felt. Amongst other things, the editor had to carry out his ordinary Corps duties concurrently with the work of editing the *Papers*. Capt. C. S. Hutchinson, for instance, was Professor of Mathematics at the Royal Military Academy, Woolwich, and was afterwards employed in the Railway Department of the Board of Trade for the 13 years (1862–1875) during which he acted as editor.

The work had become too heavy for one officer to carry out efficiently in addition to his other duties. An association of officers, destined eventually to include practically the whole of the Corps, was accordingly projected on the lines of the R.A. Institution at Woolwich. This association, which was, and is still, known as the R.E. Institute, came into being in 1875. In addition to taking over the publications enumerated above, the R.E. Institute carries out a large amount of other useful work. The Council administers

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all the Trust Funds incorporated in the Memorials Maintenance Fund, edits, prints, and issues annually, the whole of the Corps Funds Reports—including a verbatim report of the Corps Meeting—and keeps its members supplied with books, maps, etc. It is, in fact, more or less a general agency, and is frequently made use of by Government departments both at home and abroad, rarely, if ever, refusing to carry out a request within reason made by a member.

An officer has hitherto been appointed every five years to act as secretary of the Institute, the work of editing the *Professional Papers* constituting one of his duties.

Meanwhile, during the last years of Capt. Hutchinson's editorship, individual enterprise as well as combined effort had begun to supplement the work of the overburdened editor of the *Professional Papers*.

In 1870 the *R.E. Journal*—of which a short description will be given later—was launched by a resolution at the annual Corps Meeting; and in 1874 Colonel Wilbraham Lennox, V.C., started on his own account a series of translations of a confidential nature from foreign works on military engineering.

The duties connected with the editing of the *R.E. Journal*, as well as with the continuation of Colonel Lennox's confidential series, and the management of the Corps libraries, were eventually taken over by the Secretary of the R.E. Institute, in addition to the work of editing the *Professional Papers*.

The Institute building at Chatham, designed by Lieut. M. F. Ommaney,* was commenced in 1871 and completed in 1875.

Since 1875, members of the Institute have received the *Professional Papers* and other Institute publications free, as they pay a *pro rata* subscription to the Institute itself.

The affairs of the R.E. Institute are managed by a Council, elected at the annual Corps Meeting in London. Up to 1904 the Inspector-General of Fortifications was president of the Institute Council, but since the abolition of that office in 1904 the senior officer on the active list present at any meeting has acted as chairman.

R.E. Journal. The idea of starting a paper which should contain a list of the Corps, and such information from the various stations as might be thought interesting, was proposed by Major Richard Harrison at the annual Corps Meeting held on the 27th May, 1870. The proposition was strongly supported by Colonel W. O. Lennox, V.C., C.B., and was carried by a large majority.

From that day to this the *Pick-Axe*, as the *R.E. Journal* is familiarly called, has become indispensable to every R.E. officer.

Capt. Robert Home, who shortly afterwards brought out his well-known *Précis of Modern Tactics*, was the first editor of the *Journal*.

* Lieut. Ommaney was awarded the Fowke Medal for the design.

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2nd Capt. V. G. Clayton succeeded him as editor in 1871, and kept it going until he handed it over to Major W. H. Collins, acting Secretary of the R.E. Institute, in 1876. From this date the editorship has constituted one of the duties of the Secretary, R.E. Institute. The *Journal* was originally foolscap folio, and contained professional matter, regimental and social news, and a list of officers and stations of the Corps.

From January, 1873, the list was printed separately, and called the *Supplement to R.E. Journal.* In January, 1905, the title of this *Supplement* was altered to *R.E. Monthly List.* At the same time the size of the *Journal* was changed to royal 8vo, and its contents limited to professional matter (including much of what had hitherto been published in the *R.E. Professional Papers*) and memoirs; regimental and social news being printed in a new *Supplement* of the same size.

Capt. R. H. Vetch, who has since done so much historical work for the Corps by his biographies of Sir Gerald Graham and Sir Andrew Clarke, and by his articles on military engineers in the *Dictionary of National Biography* and in the *Encyclopædia Britannica*, was the first official Secretary of the R.E. Institute, Major Collins having carried on the work temporarily, pending the appointment of a permanent secretary.

Since 1882 publications other than the *Professional Papers* and the *R.E. Journal* have been undertaken by the R.E. Institute.

For instance, Major W. R. Slacke's *Notes on Drains and Drainage*—the first English text book on the subject—was published by the R.E. Institute in 1885; Colonel H. Tovey's *Notes on Military Law* was published in 1886; and Sir Douglas Galton's *Army Sanitation* in 1887.

The *Dictionary of Explosives* by Major J. P. Cundill, R.A., was published in 1889. Major J. F. Lewis' *Permanent Fortification for English Engineers*, 1890, Major E. C. S. Moore's *Notes on Sanitary Engineering*, 1892, and Sir Guilford Molesworth's *Railway Construction*, 1895, are all well-known text books in their various lines.

Between 1894 and 1898 Major G. K. Scott-Moncrieff published several useful handbooks. The first edition of his *R.E. Field-Service Pocket-Book* was brought out in 1894. Captain R. F. Edwards brought out a second edition of this handy little work in 1902. Major Scott-Moncrieff's other books, *Water Supply of Barracks and Cantonments*, 1896, and *Principles of Structural Design*, 1897, have already been referred to in the chapter on the Construction Course.

Perhaps the most monumental work ever brought out by the R.E. Institute, and certainly the most valuable from the historical point of view, is Capt. R. F. Edwards' *Roll of Officers of the Corps of Royal Engineers from 1660 to 1898.* This was mainly compiled from MS. rolls of the late Capt. T. W. J. Connolly—the Herodotus of the Corps—and brought up to date. In addition, references were made

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to the British Museum, Record Office, War Office, and other sources public and private. To all historians of the Corps this work is, and must always continue to be, of paramount importance. It is to be hoped that it will be kept up in the future, as is being done at the present time.

The *Sapper*.

The idea of running a monthly periodical for the rank and file of the Corps originated in the minds of three corporals—Piggott, Avis, and Beaumont—in the early part of 1895.

The matter would, however, probably have dropped had it not been taken in hand by Engineer Clerk Sergeant S. W. Hurst, who, with the assistance of the three corporals, prepared in manuscript the first copy of the periodical, which it was proposed should be called the *Sapper*.

This was laid before the Assistant Commandant, Colonel W. G. Morris, who was so well satisfied with it that he straightway convened a committee of officers to consider the desirability of publishing such a periodical. It was unanimously agreed that it would be an excellent thing for the Corps at large.

Certain rules were drawn up, which, together with the proposed composition of the committee, were forwarded to the War Office for approval. The committee is divided into two branches, the Committee of Control and the Working Committee. The Committee of Control consists of officers stationed at the S.M.E., and is presided over by the Commandant.

The Working Committee consists of warrant and non-commissioned officers. In addition to the editor, this committee consists of a publishing secretary, a treasurer, and an auditor.

The first copy of the *Sapper* was published on the 1st August, 1895. 3,000 copies were printed, and within a week of the date of publication not a single copy was to be obtained. Since then it has come out regularly every month.

The following warrant and non-commissioned officers have acted as editors of the *Sapper* since the start of the paper :—

Engineer Clerk Sergeant S. W. Hurst, August and September, 1895.

Engineer Clerk Q.M.S. F. Bone, October, 1895—February, 1900.

Superintending Clerk S. W. Hurst, March, 1900–

The first few numbers of the *Sapper* were printed in the S.M.E. Printing School. Since January, 1896, the printing has been done by Messrs. Mackay & Co., Ltd., Chatham.

All the notes and sketches which appear in the *Sapper* are contributed by the warrant, N.C.O.'s, and sappers of the Corps ; and there can be no doubt that, amongst the many agencies which keep alive R.E. *esprit de corps*, not the least valuable is the *Sapper*—the only regimental paper in the Army which is kept going entirely by the rank and file.

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TRANSCRIPT.

GERMAN CAVALRY STEEL BRIDGE EQUIPMENT.*

By MAJOR E. HARTMANN.

INTRODUCTION.

FOR its proper employment in war cavalry must be self-contained and independent of other units. During the course of its numerous duties, and particularly when reconnoitring, water will be met with—either unbridged, or with all bridges over it destroyed. Horses will have to swim across, with the help of existing or improvised floating equipment, *e.g.*, steel or collapsible boats, canoes, rowboats, rafts, floats, etc.; or else be transported on rafts or floating bridges, constructed out of regular equipment carried by the troops or improvised on the spot.

A cavalry regiment carries, as regular equipment, either four steel half-boats on two "bridge wagons," or two collapsible boats on one "collapsible boat" wagon.

The *Cavalry Fieldworks Instructions* were replaced, on the 24th October, 1907, by new and comprehensive regulations, entitled *Cavalry Pioneer Instructions.*†

These instructions give full information as to the use of collapsible boats. The new collapsible boat, instead of consisting of a centre piece and two bow pieces, is formed by only two bow pieces, a much simpler arrangement. Four saddle beams of equal length replace the three long and two short saddle beams of the old equipment.

The rest of the equipment is the same in both cases. The collapsible boat wagon has six horses, instead of four, in order to be able to keep up with the regiment on the march, and to be at hand when wanted.

The extensive experience gained in the long use of the old equipment showed that it did not fulfil requirements. The collapsible boats were found to be too flimsy, the canvas being easily damaged. In addition, the wagons were too heavy and unstable over rough ground. The problem was, therefore, to design a lighter and stronger metal boat to replace the canvas one.

Aluminium was first thought of, but it was found that it did not withstand the action of water, and was, therefore, in spite of its lightness, unsuitable for boat-building. This led to the choice of sheet steel as the most suitable material.

* From *Kriegstechnische Zeitschrift.* No. II. 1908.

† These instructions contain also information on demolition and reconstruction work by cavalry in the field.

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Extensive and very thorough experiments were carried out with these new steel boats by the Guard Corps in 1897—1898, and by the 3rd Army Corps in 1899; these experiments showed this type of boat to be eminently suited for its purpose. Some further improvements were, however, introduced, and the improved boats were then handed over to the 15th Army Corps.

The experiments, carried out at Strasbourg from 1900—1902, proved so satisfactory, that the steel boat was finally adopted for the cavalry bridge equipment.

The following are the chief points of difference between the old and the new equipment:—

(i.). The 6-horse "collapsible boat" wagon has been replaced by two 4-horse bridge wagons.
(ii.). The bi-partite collapsible boats have been replaced by half-boats, made of galvanized Martin mild cast steel.
(iii.). A fixed "chess table" replaces the loose chesses.
(iv.). Superstructure is carried for eight bays instead of six.
(v.). The whole equipment has been strengthened, not only by larger scantlings for the individual parts, but also (in the bridge for all arms) by the addition of strong intermediate supports for the "chess tables."

The chief advantages claimed are:—

(i.). Greater mobility and stability of the wagon.
(ii.). A very marked increase of strength in the steel boats.
(iii.). Increased buoyancy and adaptability to use under varying circumstances.

1. Description of the Steel Boat Bridge Equipment.

The cavalry bridge equipment, introduced by Army Order of the 19th June, 1903, was called "Steel Boat Bridge Equipment," so as to distinguish it from the "Collapsible Boat Equipment."

The equipment consists of nine distinct main parts, noticeable by the simplicity of their construction.

(*a*). *Cavalry Half-Boat.*—The half-boat (*Fig.* 1), of galvanized sheet steel, is 3·45 mètres long, 1·58 mètres broad, and ·565 mètres deep, in the clear.

The boat has a pointed bow and square stern.

The framework of the boat is formed of wrought-iron ribs, to which the steel skin is riveted.

The gunwale is perforated for the reception of the saddle beam, or crutches, at the bow and stern.

The centre batten, at the bottom of the boat, is of wood, and has two cleats, one near each end, for belaying cables when the boat is in bridge.

On each side of the centre batten there are two other wooden battens, and on the outside there are three wooden battens for protecting the bottom of the boat.

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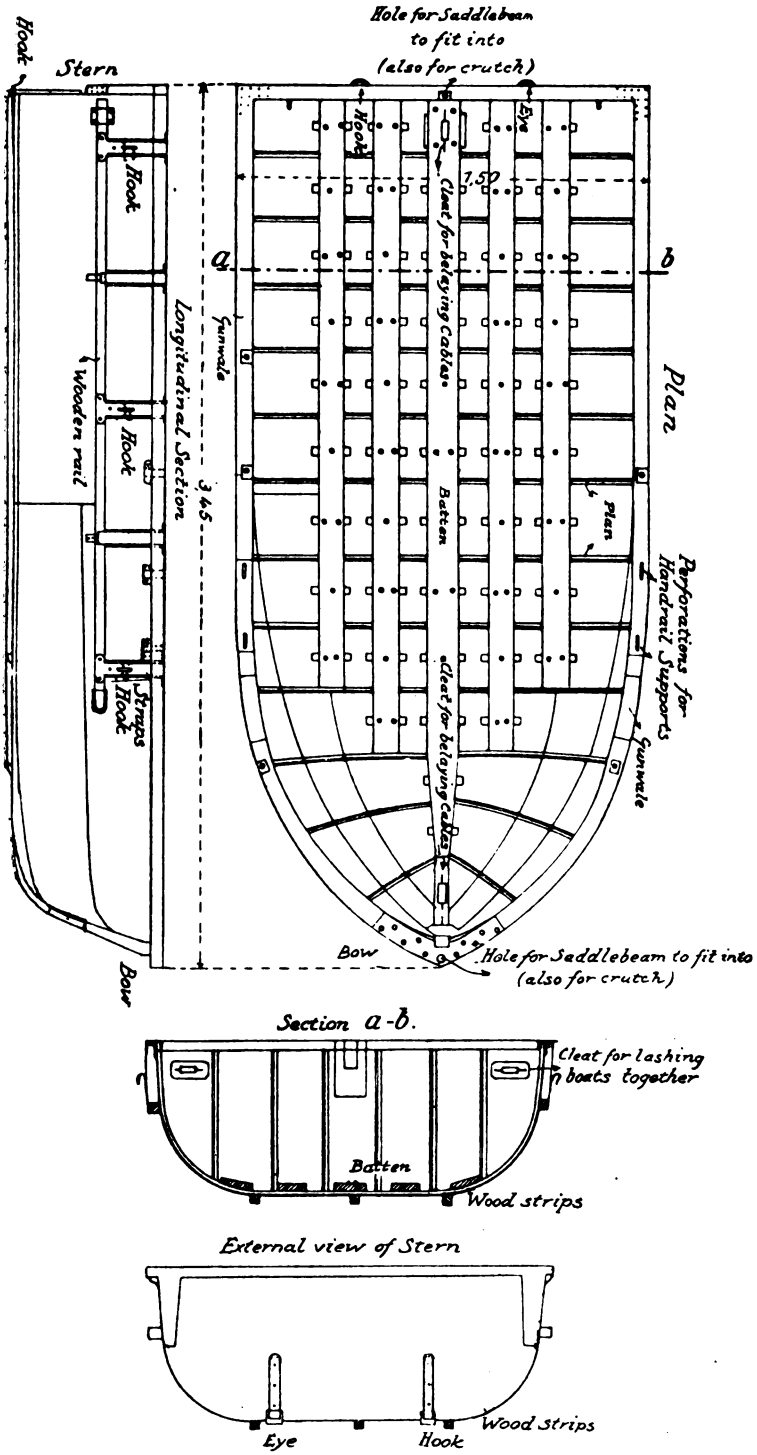

Fig. 1.

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The sides of the boat are protected by a continuous wooden rail. When packed on the wagon, the half-boats are placed one over the other, upside down, the upper boat resting on the continuous wooden rail of the lower one. This rail is supported by straps fastened to the gunwale. These straps are provided with hooks, which are used during transport "for lashing" the boats to the wagons, and during bridging for lashing the "chess tables" to the boats.

With two such half-boats, a complete boat can be formed by lashing them together by the sterns, for which purpose there are belaying pins at the top, and hooks and eyes at the bottom (*Fig.* 2).

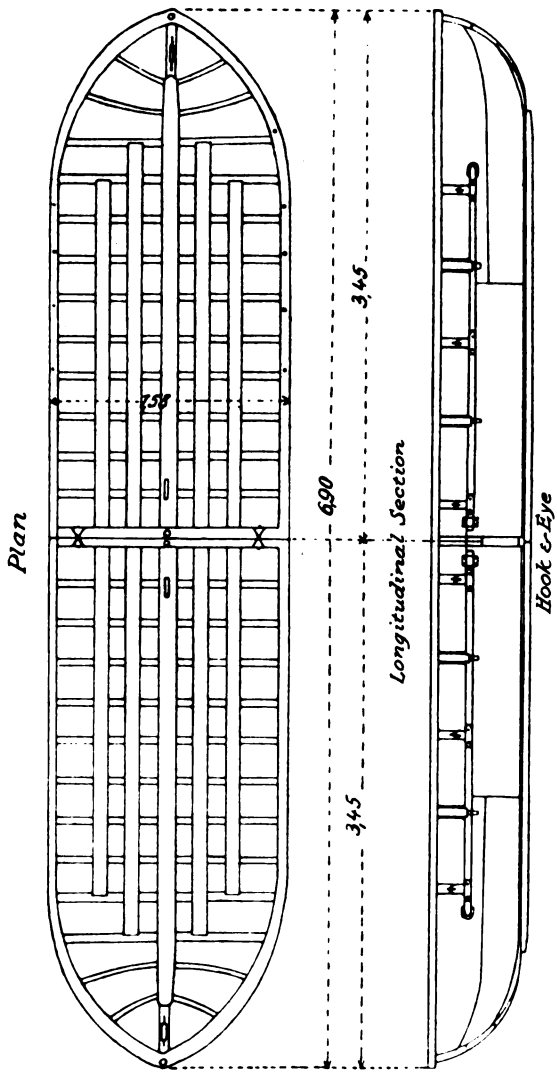

Fig. 2.

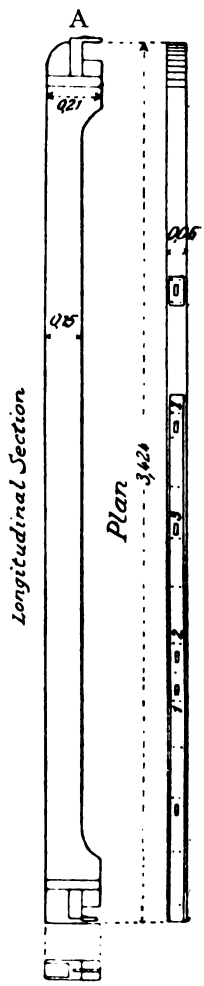

Fig. 3.

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The forming of these two half-boats into one can be done either on land or in the water. The latter method is generally preferable, the half-boats (which weigh approximately 132 kg.) being more easily handled on shore than the whole boat, and moreover are easily joined together in the water.

(*b*). *The Saddle Beam.*—The saddle beam (*Fig.* 3) is made of pine, and serves as a support for the superstructure, which consists of "chess tables." Its length is 3·424 mètres, its width ·06 mètre, and its depth ·15 mètre, except at the ends, where the depth is increased to ·21 mètre.

The curved end A fits into the hole at the bow, the other end going into the hole at the stern, thus forming a fixed and firm support along the length of the boat. Several perforations will be noticed along the upper surface of the saddle beam. These are for the reception of the handrail supports, which occupy different positions, according to the different widths of the bridge. That marked (i.) is used in the light foot-bridge, whilst (ii.) is for the two "chess table" bridge, and (iii.) for the three "chess table" bridge.

The two unnumbered perforations are for the supports when the "chess tables" are used with the half-boat.

The weight of the saddle beam is about 20 kg. It can also be used as a shore transom, being sunk slightly into the ground, and made fast to six pickets.

(*c*). *The "Chess Table."*—The pine "chess table" (*Fig.* 4) forms the superstructure. It is made in such a way as to dispense with the necessity of ribands, and is 4 mètres long, 1 mètre broad, and consists of three ·14-mètre × ·04-mètre road-bearers, with chesses screwed on. The chesses are of pine, ·02 mètre thick. The weight of the table is about 92 kg. The two outer road-bearers fit on to the saddle beam with claws, and the centre one with an iron attachment. When used in raft, the claws fit on to the gunwales of the boat. When two or more "chess tables" are alongside each other, the centre road-bearer is clamped to the saddle beam by means of the eyes on the iron attachment. The chesses are screwed to the road-bearers, as nails are liable to drop out.

(*d*). *The Intermediate Support.*—The intermediate support (*Fig.* 5) is used, in two and three "chess table" bridges, for fastening them together and bracing the road-bearers. It is made of pinewood, is 3·15 mètres long, 1·08 mètres deep at the middle, ·06 mètre at the ends, and ·065 mètre wide. For fixing it to the "chess table" there are two single and two double hooks. The hooks grip the top of the "chess table," and are tightened up by means of bolts with wing nuts. Accidental unscrewing is guarded against by means of a ring clip. The weight of the support is about 44½ kg.

(*e*). *Handrail Support.*—The handrail support (*Fig.* 6) is made of ash. It is 1·19 mètres long, 1·3 mètres to the end of the iron shoe, and is ·05 mètre square. At its upper end it is provided with an iron ring for threading or fixing the handrail, whilst at the lower end the iron shoe is pointed, and fits into holes in the saddle beam. In a raft it fits into holes in the gunwale, and its weight is approximately 1·75 kg.

(*f*). *Anchor.*—The anchor weighs about 30 kg., and consists of two

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flukes, and a movable stock fixed at right angles to the shank, so as to prevent the flukes from resting flat on the ground without getting any hold.

The anchor is used for keeping the floating piers in position. Its weight, although slight compared to that of the bridge train anchors, is, however, sufficient, under ordinary circumstances, for the light steel boats. If a heavier anchor is required in exceptionally swift-flowing waters, two

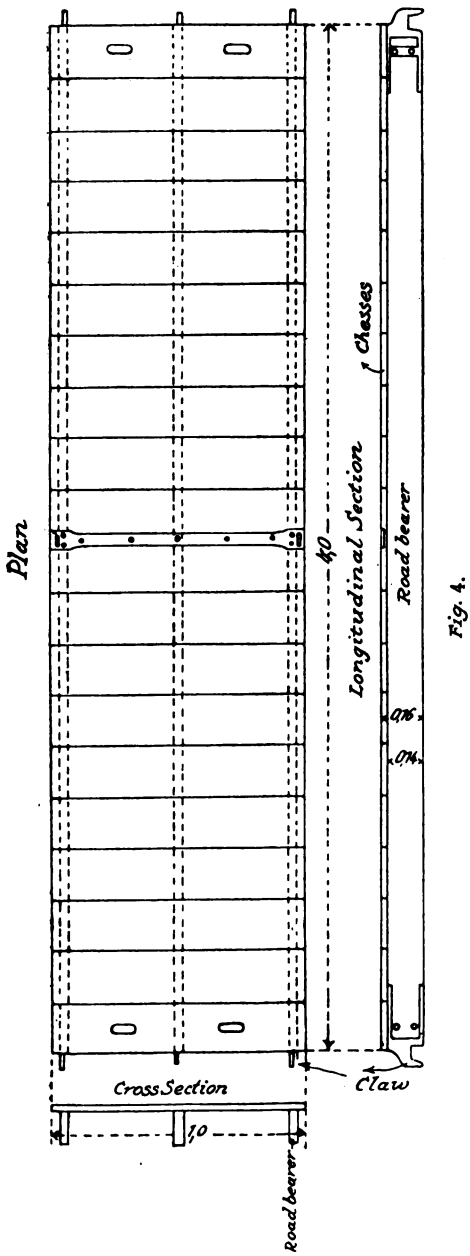

Fig. 4.

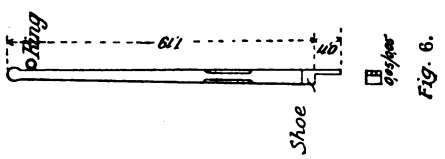

Fig. 6.

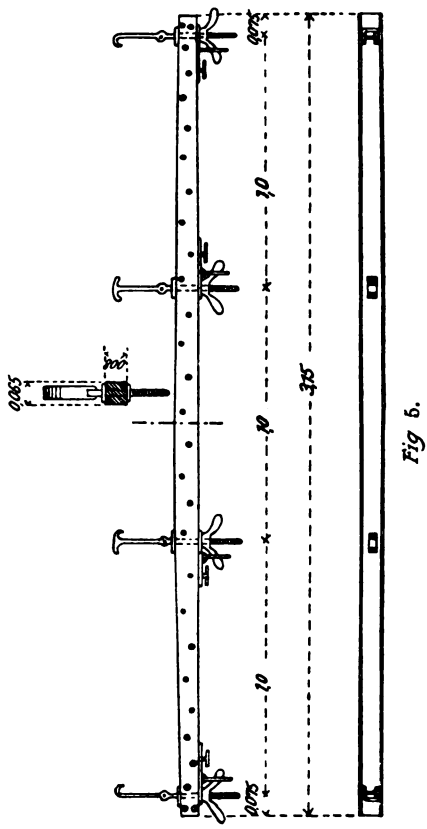

Fig 5.

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anchors can be coupled together. The anchor of the collapsible boat equipment only weighed 22 kg., but dragged continually.

(*g*). *Cordage.*—The anchor cables, 35 mètres long, are only half the length of the collapsible boat cables. The size of the ropes has not been altered, and is ·015 mètre. The weight is 6·6 kg., *i.e.*, only 2·8 kg. less than the collapsible boat equipment cables. The reason for this is that the new cables are more tightly spun, and contain a greater quantity of hemp.

The ropes, used for the handrails and for lashing the boats together, are 6·5 mètres long, and ·01 mètre in diameter, and each weighs 5 kg. The remaining lashings are of rope ·008 mètre in diameter, cut in lengths of 2·5 mètres, and weighing ·16 kg. These lashings formed no part of the collapsible boat equipment.

(*h*). *Oars, etc.*—The oar is made of fir, and is in one piece. It is 3 mètres in length, embracing handle, boom, and blade—the latter being shod with a brass band on its rounded end. The oars weigh about 4 kg.

The iron crutch has a cylindrical stem and two prongs—weight about 4 kg.

A fir pole, 4·2 mètres long, is carried. Its mean diameter is ·05 mètre, and it has one blunted iron-shod end. It is divided into ·25-mètre intervals for measurement purposes, and its weight is about 35 kg. No boathook is provided, and the pole cannot be used as such.

(*i*). *Shore Picket.*—The shore picket is made of ash, and is 5 mètres long, and ·006 mètre in diameter. It is pointed and shod with iron at one end, and the other end has an iron ring let in. Its weight is about 5 kg.

2. Packing of the Steel Boat Equipment.

Special 4-horsed wagons are used (*Figs.* 7 and 8) for carrying the equipment. A cavalry regiment is equipped with two of these wagons, loaded with :—

4 steel half-boats.	12 shore pickets.
8 chess tables.	6 saddle beams.
6 handrail supports.	4 intermediate supports.
12 oars.	2 anchors.
8 poles.	12 crutches.
16 handrail and connecting lashings.	4 cables.
	8 short lashings.

Figs. 7 and 8 show how these stores are carried. It should be specially noticed how accessible everything is; any portion of the equipment can be got out without any great dislocation of the remainder. The stores carried are as under :—

In the fore-carriage recess "A"...	Wagon equipment and stores.
In the space "B"	Bridge equipment.
In the well "C" behind the axle...	Half the demolition equipment, bridge and boat small gear.
Under the box seat "D"	A large forage sack with four 1-day's rations.

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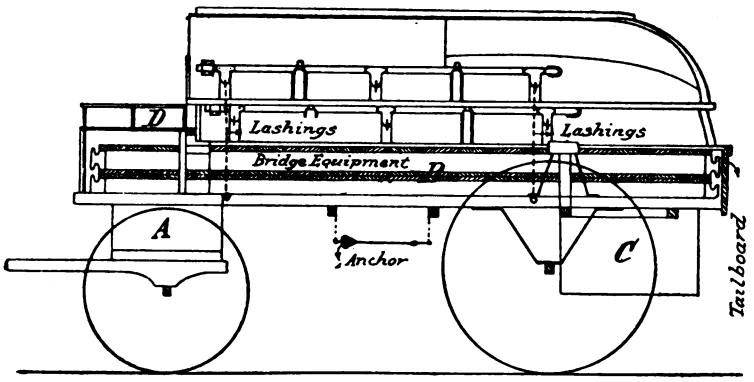

Fig. 7.

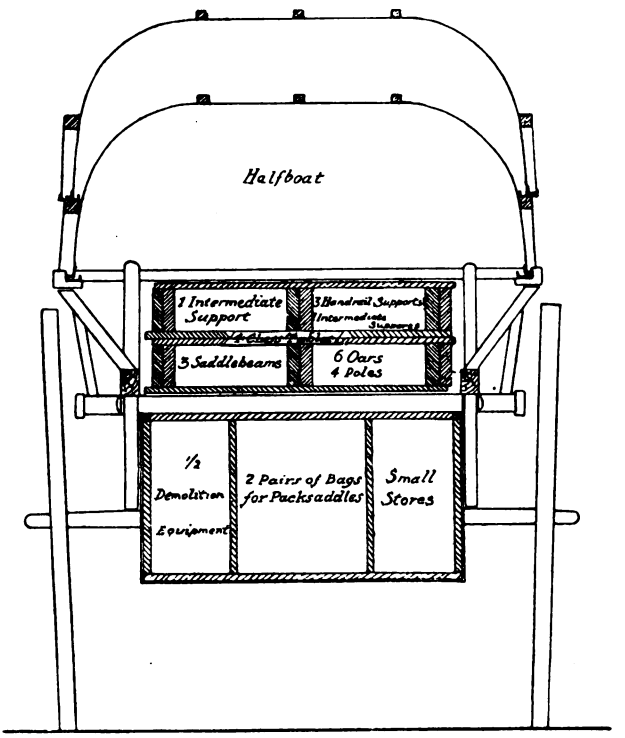

Fig. 8.

In cases where the site or type of bridge have not been fully determined, a depôt* should be established on the bank at the water's edge near the probable site (*Fig.* 9). The stores are unpacked, and for this purpose two

* The author in a footnote objects to the use of a foreign word like "depôt" in an official German pub ication, and suggests several words that might have been adopted without borrowing. — *Translator.*

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detachments are told off. One detachment, consisting of one N.C.O. and eight men, unloads the boats, boat and anchor gear, and saddle beams. The second detachment, of one N.C.O. and four men, unloads the rest of the bridge equipment. The boats are at once placed in the water, and made fast to the shore. The requisite number of chess tables and intermediate supports are placed upstream of the line of bridge, and the remaining stores are placed downstream. The same order of laying out the stores should be always strictly adhered to, to facilitate work when darkness has set in.

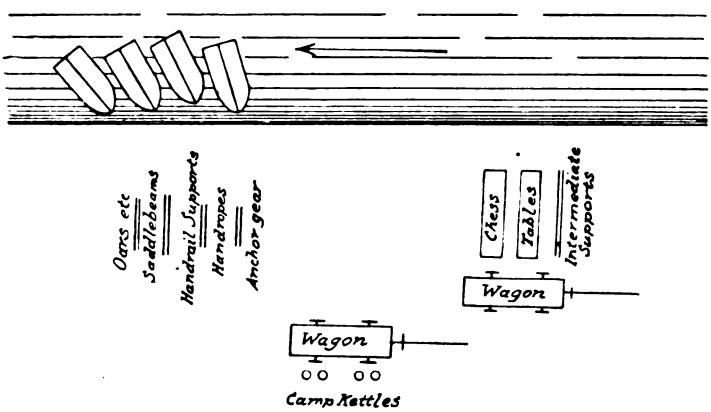

Fig. 9.

If a bridge is to be thrown across immediately, the wagons, on their arrival at the site, should be brought up facing upstream, and no special depôt need be formed. The stores, to be used in the bridge or raft, are then unloaded by the bridge detachment, and it is unnecessary to tell off special unpacking detachments. No unnecessary stores are to be unpacked.

Before a bridge or raft is broken up, the wagons must be transported across to the far bank. As, in unpacking, the boats were the first to be taken off, so, in packing, they are loaded last. The wagons should be placed facing downstream, and the half-boats are placed over each other as soon as they are brought out of the water, and before they are placed on the wagon.

3. METHOD OF ANCHORING STEEL BRIDGES.

A good anchorage is essential, so as to furnish the necessary rigidity of a steel boat bridge against both current and wind. The method adopted depends on width of stream, velocity of current, and nature of river bed. *Fig.* 10 shows a way of anchoring a short footbridge, the cables being fixed on shore. *Fig.* 11 shows how a long three chess table bridge can be anchored. This bridge absorbs the equipment of six cavalry regiments, *i.e.*, a cavalry division. The main anchorage of this bridge is in the water, and each boat is attached to an upstream and a downstream cable. In order to cross such a bridge as rapidly as

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possible, it is recommended that the horses be swum alongside the bridge. If this is done, the downstream anchor cables must be removed. If, however, the wind is strong, in comparison to the current, so that there is a danger of the bridge bulging on the upstream side, the horses had better not be swum.

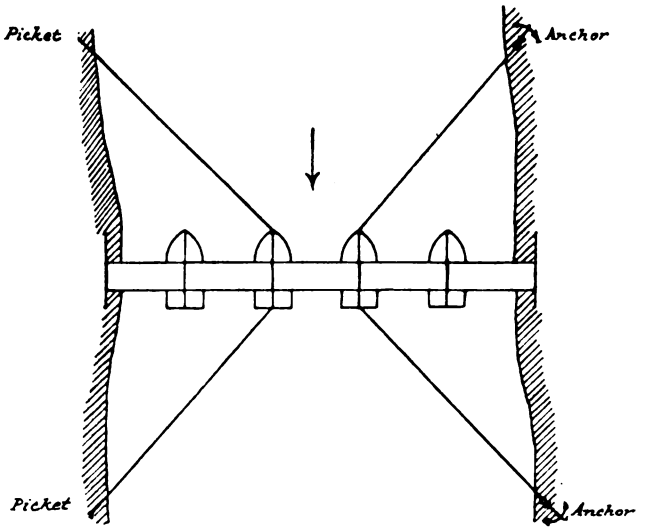

Fig. 10.

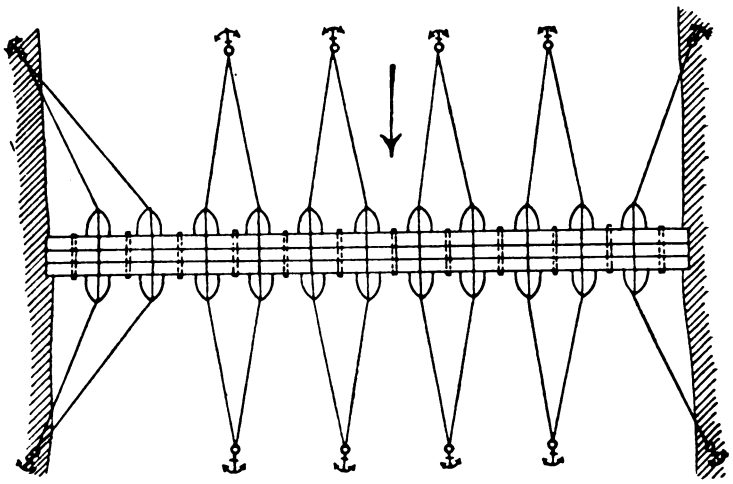

Fig. 11.

Experience has shown that the dragging of anchors, on account of the flukes not getting a sufficiently firm hold of the bed, is not solely due to lack of weight of the anchor, nor does such dragging happen to the upstream anchors only. It is more often the case that, in the gravelly beds of streams with strong currents, the whole bed is shifted bodily

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downstream, taking the anchor with it. Dragging of the anchor can always be noticed by the slackening of the cable, and this must be carefully watched for.

Cables can be fixed to a picket on shore, instead of making use of an anchor.

4. DIFFERENT FORMS OF BRIDGE.

(*a*). *Footbridge* (*One Chess Table*).—The light footbridge (*Fig.* 10) is used for transporting the men with their saddlery and kit, horses being swum across, guided by a lance, close to the bridge on the downstream side.

This is accomplished as follows:—The arm band is placed between the two upper pennon rings, and then fixed on to the throat lash ring of the halter, so that the point of the lance projects about ·2 mètre beyond the side of the horse's head, thus avoiding risk of injury to the latter. When swimming horses in this manner, two men in the water must lead the horse into the water until it no longer offers resistance to the man with the lance. The man with the lance must conform to the movement of the horse, and a judicious use of the whip from the bank will appreciably expedite the operation. This form of bridge is, as a rule, only applicable in slow-flowing streams, and only half-boats are used. The bearing* is 4 mètres, and is the same in all bridges, being regulated by the length of the chess table. Before being put into bridge, every half-boat is equipped with one oar, one crutch, one handrail support and line, and the saddle beam is placed in position as support for the chess tables.

With the regulation bearing of 4 mètres, a cavalry regiment can, therefore, with its four half-boats, form a bridge 20 mètres long, using five chess tables and the half-boats as piers.

With the above form of bridge a special shore transom is not necessary, the shore ends of the chess table being stuck in the ground.

When, owing to the depth of the water, all four boats cannot be used, or such a length of bridge is required as to use all eight chess tables, *i.e.*, 32 mètres, improvised piers must be constructed. For this purpose piles of the simplest nature are sufficient, and two piles, driven into the ground 1·8 mètres apart, will fulfil all purposes. A saw-cut is made in the head of each pile, as shown in *Fig.* 12, and the saddle beam placed in the notches and lashed.

(N.B.—This bridge would require seven saddle beams, whereas only six are carried.—*Translator*).

The use of iron bands, for fixing the saddle beam on to the head of the piles, is not recommended, as they tend to damage and shorten its life.

The bracing of the piles is to be done in as simple a manner as possible (*Fig.* 13). They must, however, be braced, in order to prevent swaying of the bridge during the passage of the troops. These improvised piers must be 4 mètres apart.

Additional work may sometimes be required on marshy banks, involving the laying of chesses, or even bridging with small trestles or cribs.

* The expression bearing has been used according to the latest instructions instead of span. Bearing is accordingly the distance between the centre of the supports.

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(*b*). *Bridge with Two Chess Tables.*—The bridge in *Fig.* 14 can be constructed with three floating piers, *i.e.*, one half-boat, one complete boat, one half-boat, and eight chess tables, *i.e.*, the equipment of one regiment. This bridge is 16 mètres long and 2 mètres wide. Led horses can cross the bridge in single file with intervals; men in file breaking step; and light unloaded vehicles can be drawn over by hand.

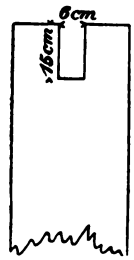

Fig. 12.

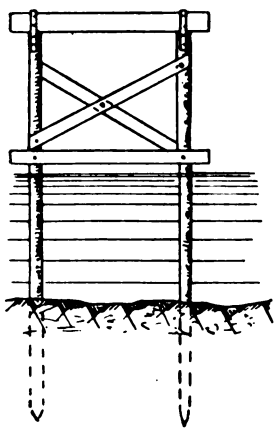

Fig. 13.

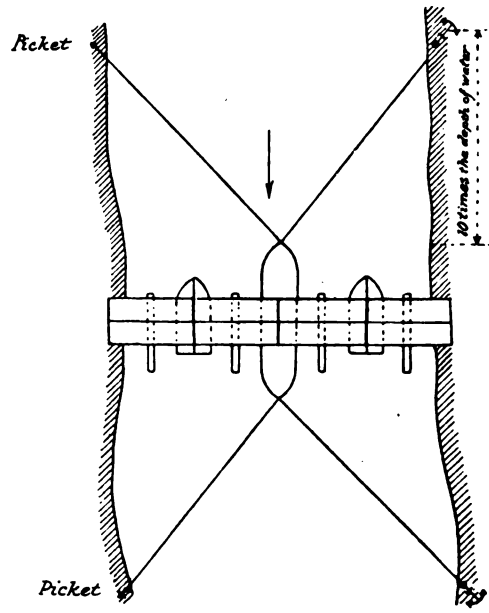

Fig. 14.

The two rows of chess tables are joined together, in each bay, with an intermediate support. As in the light bridge, no shore transom is required, but six shore pickets must be driven against the end of the chess table to keep it in position.

(*c*). *Strengthened Bridge* (*Three Chess Tables*).—In building the strengthened bridge (*Fig.* 11) only complete boats are to be employed. Ridden horses, in single file, can cross this bridge, also infantry in fours at double interval and breaking step. Also a field gun, ammunition wagon, S.A.A. carts, and light baggage carts can cross. All vehicles to be at 10-pace intervals, and limbered vehicles to be unlimbered.

It is only by strictest compliance with these instructions that the full utility of the bridge will be preserved. It is true that the carrying capacity is sufficient to support a heavier load for a short time, but a slight gain of time, enjoyed by the first troops, would be more than counteracted by the lack of stability of the bridge later on.

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It is in crossing these bridges that the impetuosity of the cavalry soldier must be checked by wise moderation, for, the more quietly the operation is carried out, the greater will be the order, and the quicker the passage.

The superstructure consists of three rows of chess tables, kept together by intermediate supports. The more complicated the bridge, the more the various parts are apt to shake loose, if the greatest order is not preserved while crossing. In exceptional cases the bridge equipment of a regiment can be used for building "three chess table" bridges, 8 and 12 mètres long (*Figs.* 15 and 16).

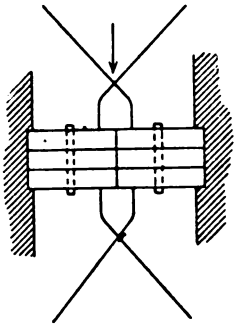

Fig. 15.

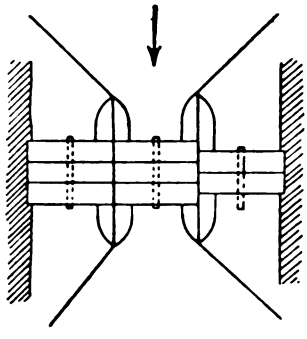

Fig. 16.

In the 12-mètre bridge, one shore bay is formed of two chess tables only, laid with their intermediate support centrally to the bridge. In a similar manner, when the equipment of several regiments is used, should there be an insufficient number of chess tables, the two shore bays can be formed with two chess tables.

Such bridges can be used by cavalry and infantry as two chess table bridges, and as strengthened bridges for vehicles.

Very often the bridge equipment can be used to advantage for crossing broad ditches with steep sides or soft bottoms.

A cavalry division has sufficient equipment to construct

120-mètre light foot bridge,
96-mètre two "chess table" bridge,
or 48-mètre strengthened bridge;

but only the last of these gives full security along the whole length.

A 120-mètre bridge can be built, but it is not well adapted for the passage of troops on account of its great swaying, since its design presupposes a sluggish stream. In a moderate current so long a bridge would simply capsize, owing to want of rigidity. Even the 96-mètre bridge calls for the greatest caution.

The question of only using complete boats, and of making up the other piers out of trestles, depends on circumstances, such as the supply of local material.

(N.B.—The maximum measurements given above are difficult to reconcile with the equipment carried.—*Translator*).

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5. Rafts.

In forming rafts with the equipment, only complete boats are to be used, the superstructure consisting of four chess tables and the saddle beams being dispensed with. Each complete boat is equipped with one pole, three oars, three crutches, two handrail supports, two handrail lines, and four lashings.

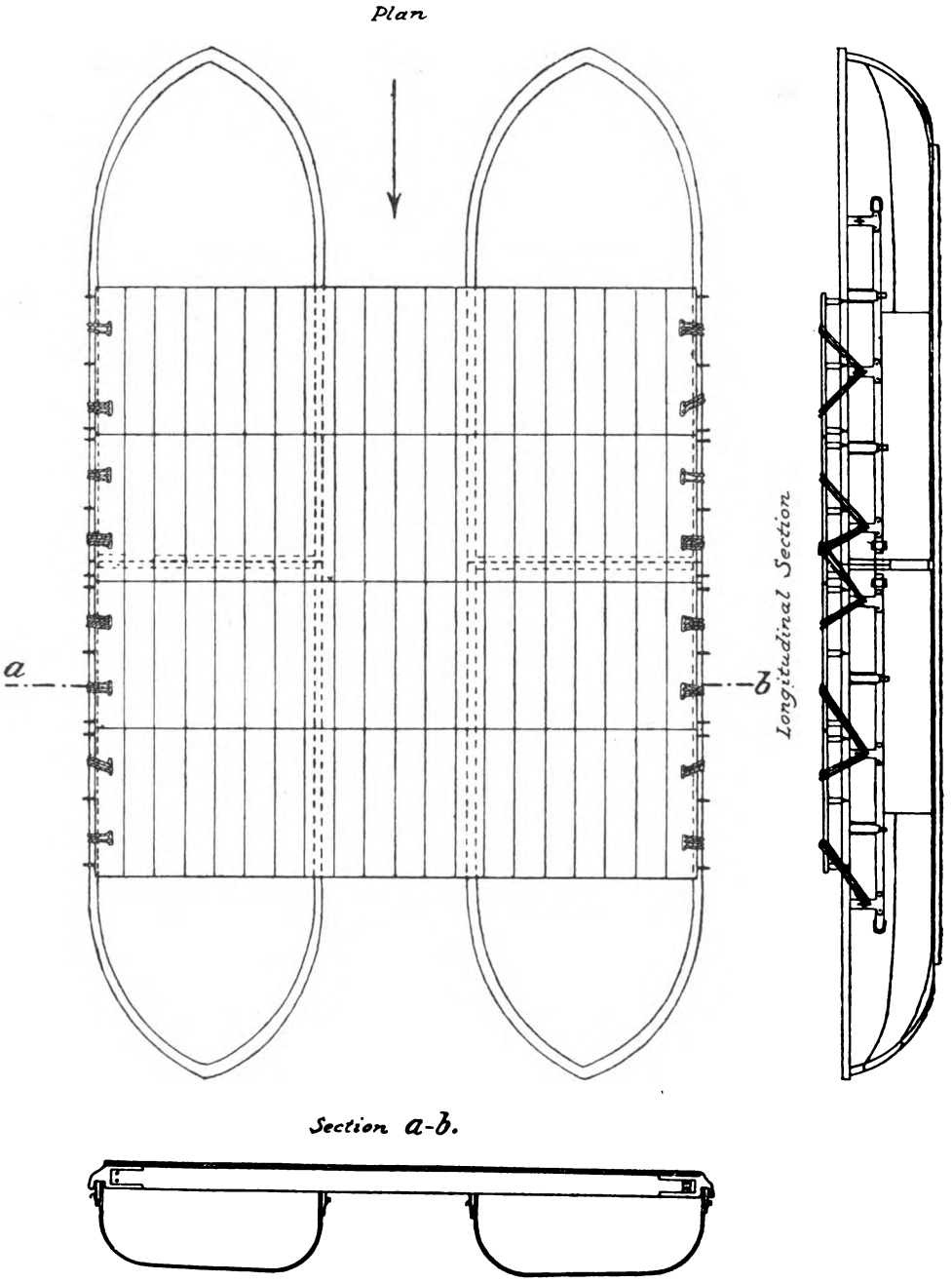

Fig. 17.

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The chess tables are lashed (through the hand holes in the outer chesses) to the hooks on the outside of the boats. The outer bearer of the centre upstream chess table fits over the gunwale of the downstream half-boat (*Fig.* 17).

The lashing must be done with the greatest care, as the whole stability of the raft depends on it, and the lashings must be frequently looked to, and any slack immediately taken up. As a rule, a special landing stage is not required, that is to say, when only a horse and its rider are dealt with, but where guns or wheeled traffic have to be off-loaded, a gangway has to be constructed out of the surplus chess tables.

In this case the chess tables are fixed on to a saddle beam on shore, and the off-shore ends hooked on to the shore gunwale of the raft on arrival.

The gangway chess tables are joined together by an intermediate support (*Fig.* 18).

A cavalry regiment has sufficient equipment for one raft, and the construction of a two chess table gangway on each bank.

If the equipment of several regiments is available, and the raft cannot approach sufficiently close inshore on account of want of water, a floating pier will have to be constructed out of the surplus bridge equipment (*Fig.* 19). In calm water rafts can be got across by means of the poles or oars, but if there is a sufficient current, the raft can be used as a flying bridge, necessitating a transverse cable, the current supplying the necessary power. This is done as follows:—

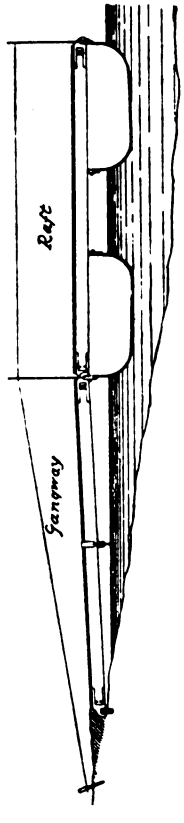

Fig. 18.

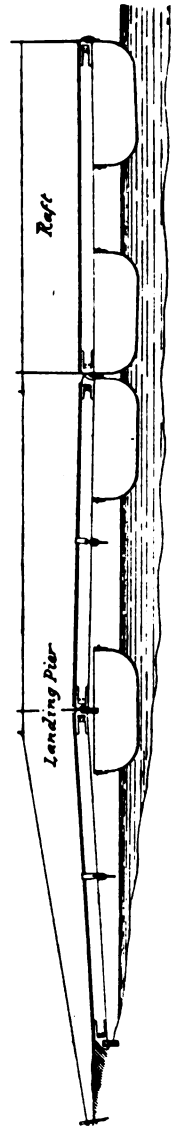

Fig. 19.

If a raft, attached to a cable crossing a stream, is kept at an angle to the direction of the current, the raft will move straight across the river in the direction of the bows of the upstream boat. The motion is caused by the pressure of the current on the sides of the raft, as long as it

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remains in its proper position. This position is maintained either by steering with the oars, or by means of double ropes. These ropes are attached to the cable with a running noose, and held, by hand, in the bows of the boats. By drawing in or letting out these ropes, the raft is kept at the correct inclination.

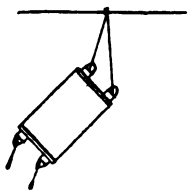

Fig. 20.

With the steel boat bridge equipment, a rope is stretched taut over the river and firmly fastened, on each bank, to a tree or stout picket, care being taken to keep it as taut as possible. The raft, at the correct inclination to the current, is moved across the stream either by direct pull or by means of a roller on the rope and bridle reins (*Fig.* 20). The use of the raft, as a simple ferry, is only possible in very weak currents, and the raft is then pulled across the stream by men on either bank.

6. Organization of Work.

For building the light bridge, the working parties are detailed as follows:—To each half-boat a crew of two, or one N.C.O. and eight men for the equipment of a regiment. In addition, a carrying detachment (for the equipment of one to three regiments) of one N.C.O. and four men is required.

When orders are given to construct the bridge in double time, the carrying detachments are to be increased, and special unpacking detachments added. An adequate reserve is also to be provided whenever special works have to be carried out, such as the formation of approaches and the erection of trestles.

In the case of the two chess table bridge, the men are told off as follows:—

A crew of two men to every half and complete boat, and consequently for a complete regiment one N.C.O. and six men (*Fig.* 14).

Two carrying detachments, four men each (for the equipment of one to three regiments), and a suitable reserve for special work.

For strengthened bridge, the crew for each boat is also two men, consequently one N.C.O. and four men per regiment. Three carrying detachments, four men each (for the equipment of one to three regiments), and a reserve for special work. In building an 8 or 12-mètre strengthened bridge (*Figs.* 15 and 16), 20 minutes should be allowed, and one hour is sufficient, if the whole equipment of a cavalry division is utilized, in forming a similar bridge, 48 mètres in length.

The quicker the wagons can be unpacked, the quicker will be the bridge completed. The time should, however, not be underestimated, as frequently the approaches, etc., take up more time than building the bridge itself.

In this respect an officer's patrol sent ahead to reconnoitre the point of passage is of considerable advantage.

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7. CAPACITY OF THE EQUIPMENT.

The buoyancy of a complete boat is sufficient for 10 infantry soldiers with equipment, or eight cavalrymen with saddlery and equipment.

(*a*). *Complete Boat Bridge.*

Equipment of ? Regiments.	No. of Complete Boats.	Buoyancy.		Remarks.
		Infantry with Equipment.	Cavalry with Saddlery and Equipment.	
1	2	20	16	(1) Crew (1 coxswain, 2 rowers) not included.
2	4	40	32	(2) With strong wind and rough water these numbers are to be reduced.
3	6	60	48	
4	8	80	64	
5	10	100	80	
6	12	120	96	

(*b*). *Rafts.*

Equipment of ? Regiments.	No. of Rafts.	Buoyancy.				Remarks.
		Infantry with Equipment.	Horses and Horseholders.	Saddle Equipment of Cavalrymen.	Guns and Gun Numbers or Transport Vehicles.	
1	1	30	4	50	1	(1) Crew (1—2 coxswains and 4 men for each raft) not included.
2	2	60	8	100	2	(2) With strong wind and rough water these numbers are to be reduced.
3	3	90	12	150	3	(3) For the construction of landing stages each regiment has 4 chess tables and 6 saddle beams available. If boats are required for landing piers, then the number of rafts has to be decreased.
4	4	120	16	200	4	
5	5	150	20	250	5	
6	6	180	24	300	6	(4) Horses are only to be put on rafts as quite an exceptional measure.

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(*c*). *Lengths of Bridges.*

Equipment of ? Regiments.	Light Foot Bridge.		Two Chess Tables.		Strengthened Bridge.			Remarks.
	Floating Piers only.	Employment of all Chess Tables with Trestles added.	Floating Piers only.	Employment of all Chess Tables with Trestles added.	Floating Piers only.	Employment of all Chess Tables with Trestles added; all Bays 3 mètres wide.	Employment of all Chess Tables with Trestles added, with one or both Shore Bays a mètres wide.	
	Mètres.	Mètres.	Mètres.	Mètres.	Mètres.	Mètres.	Mètres.	
1	20	32	16	16	8(2)	8	12	(1) One half-boat not used.
2	36	64	24(1)	32	20(3)	20	24	(2) Complete boat not used.
3	52	96	36	48	28(3)	32	32	(3) The length of the bridge is reduced by 4 mètres if a complete boat is used as an anchor boat or for protective and salvage work.
4	68	128	48	64	36(3)	40	44	
5	84	160	56(1)	80	44(3)	52	56	
6	100	192	68	96	52(3)	64	64	

"Cavalry far ahead—Reconnaissance!" With these four striking words our great Moltke emphasized the first duty of cavalry in war; and this exhortation applies not so much at the beginning of, but rather for the whole campaign. To fulfil this duty the cavalry is called upon to act independently of other units, and must, therefore, be self-contained. To accomplish this, the whole equipment of cavalry must be as far reaching as its weapons. But it can never successfully fulfil its *rôle* in the domain of war if it lacks a comprehensive technical training, enabling it to carry out its allotted task in the field, pre-eminent amongst which is the crossing of rivers by means of regular or improvised equipment.

The new steel boat equipment has presented the German cavalry with an incomparable weapon for accomplishing this object, excelling all other field equipments by the simplicity of its construction. Its weight is insignificant, its stability unimpaired, and it is undoubtedly superior to the collapsible boat.

The whole equipment of the steel boat bridges is not only more durable and easier to transport, but it is more easily handled. These facts are firmly established when the steel boat is compared with the collapsible one.

May our cavalry only do full justice to the new equipment.

G. H. Fowke.

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NOTICES OF MAGAZINES.

MEMORIAL DE INGENIEROS.

September, 1907.

SAPPERS AND MINERS: THE FOURTH ARM.—By Major D. Ricardo Burguete.—The Japanese were the first to make use of their engineer troops as a true fourth arm. Even before the war in Manchuria one battalion of engineers was attached to each division, a proof of the importance they attached to the use of this arm. The corps played its part in this campaign with the greatest success, and the author of this article desires to point out the still greater part it is destined to play in the future, not merely in the defence, but also on the offensive.

In the attack, the engineers have two duties to perform:—(*a*). To prepare the infantry assault in that zone in which the artillery is unable to co-operate, and (*b*) with the aid of mines, after the assault has been delivered, to confer offensive power on those sections of the position which, for topographical or tactical reasons, are considered to be weak.

With regard to (*a*), when the time has come to assault the enemy's position, and the attacker has come to such close quarters with the defence that his artillery is no longer able to assist him, he is in need of something to help him in crossing the last few yards, and this assistance can be given him by the engineers, who will hurl explosives against the enemy's position.

With regard to (*b*), weak flanks may easily be made strong by the use of mines, and points in the line of battle, which are subject to such heavy fire that it is dangerous to assemble many troops upon them, may be strengthened in the same manner.

Ground taken from the enemy may be mined, and then abandoned, with the intention of blowing him up when he again reoccupies it.

The author considers that the Spanish race is specially well adapted to supply sufficient sappers with the nerve and daring necessary for taking an active share in the attack, and, though an infantry officer himself, he seems to have the highest opinion of the corps and of its future.

THE MINISTRY OF WAR IN THE MADRID INDUSTRIAL EXHIBITION (*concluded*).—The General Staff exhibited an interesting and varied collection of maps and plans, which included Claudius Ptolemy's *Eight Books of Geography*, published at Rome in 1535, and several rare seventeenth century maps of the West Indies and America, as well as the $\frac{1}{200000}$ Military Itinerary Map of Spain, which is not yet completed, the new $\frac{1}{50000}$ map of the Pyrenees reduced to a scale of $\frac{1}{200000}$, a reduced

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map of the Campo de Gibraltar, 14 sheets of the new map of Morocco, with plans of Marrakesh, Mepnes, Larache, Tangier, and various Riff Kábilas.

The Artillery Museum, which possesses one of the finest collections of arms in Europe, made a good exhibit, over 80 in number.

The Corps of Engineers exhibited models of various fortresses, such as Bilbao, Gerona, and Melilla, and of the Danish bridge train which has been recently adopted in the Spanish service, and which has the reputation of being amongst the best in the world.

THE AUTOMOBILE SERVICE IN OUR ARMY.—By Capt. D. Ricardo Goytre.—The first motor cars in the Spanish Army were a 12 and 24-h.p. Peugeot, which the Marqués de Puerto Seguro presented to the 2nd Regiment of Sappers and Miners in September, 1903. The first of these was made in 1898, and took part in the Paris-Ostend race in 1899, in which it took first place. Though of so early a type, it is still running well. The 24-h.p. machine was made in 1900, and at that date was considered a very powerful car; owing, however, to faults in the design, it was always breaking down, and was never so reliable as the earlier model. The present article, which is to be continued, contains pictures and diagrams of both cars, which are of some interest to those who care for the archæology of motorism.

MILITARY REVIEW.—Opinions of Capt. Mahan and Mr. S. Sims on war vessels and marine artillery, deduced from the Russo-Japanese War. This is a summary of articles which appeared lately in the *Proceedings of the United States Naval Institute.* Capt. Mahan's opinion is that the superiority of the Japanese resulted from their choice of their position in respect to the presumed objective of the enemy, and not to the superior speed of their ships, which speed does not constitute an essential advantage either from the tactical or the strategical point of view. By this he does not mean that speed is valueless, but that it is not to be aimed at at the expense of armament. He further considers that the suppression of guns of medium calibre is a retrograde step.

Mr. Sims, who is the United States inspector of artillery, combats both these views, and is a vigorous upholder of the fast, one-calibre battleship of the *Dreadnought* type.

'M.'

REVUE DU GÉNIE MILITAIRE.

January, 1908.

THE INFLUENCE OF THE SIEGE OF PORT ARTHUR ON THE CONSTRUCTION OF FORTS.—*A continuation of the previous articles.*—The proper *rôle* for a fort is to defend both itself and the intervals on either side of it. It should be regarded as a point of support, which enables the garrison of the fortress

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to manœuvre and make counter-attacks in its vicinity. In order that a fort may fulfil its destiny, it should be able to command, with its guns, the obstacles on its front and flanks, and, in addition, obstacles, guns, and garrison, should be so shielded that the enemy cannot destroy them with his artillery. The advent of the gorge caponier, from which the intervals on either side may be flanked by infantry and machine-gun fire, marks an epoch in fortress warfare.

It is a great mistake to provide a fort with guns heavy enough to engage the besieger's artillery. Where heavy guns are mounted in a fort, the besieger can bombard them day and night, with the satisfaction of knowing that even if he is not harming the guns, he is inflicting losses on the infantry garrison. By mounting the heavy guns outside the forts, it is possible to conceal their positions.

The writer discusses the design of Ehrlong Fort, and its defects. Four large guns were mounted in a battery in the centre of the fort. These guns offered an easy target, and the Japanese were consequently able to silence them whenever they pleased. The right flank of the fort was enfiladed from Takushan, and the left from Wolf Hill. To obviate these defects, traverses were constructed along the flanks at intervals of 12 feet, and finally the spaces between were roofed in with boards covered with earth. The interior of the fort was not drained; consequently the rain-water ran into the counterscarp gallery through the tunnel under the ditch. The only exit from the gallery then lay through some very narrow embrasures.

The casemates, which were built under the gorge parapet, had been designed for a company at peace strength. The garrison consisted of a company at war strength, and was often reinforced by a second one. Caponiers, counterscarp galleries, and gun shelters had then to be used as barracks. There were no means of lighting or ventilating the galleries and casemates, and the whole condition of the fort was most insanitary. There were no officers' quarters.

A defect, which was very severely felt, was the absence of a covered passage from the gorge casemates to the front parapet. When the fort was under fire, the garrison of the front parapet were completely cut off from their food and water supplies. Finally, it became necessary to dig a zigzag communication trench from the gorge to the front parapet, and even this gave only indifferent cover. The exit, from the gorge casemates into the fort, was not properly defiladed, and many losses occurred at this point.

Another defect, that made itself apparent, was the absence of proper shelters for the guns destined to repel assaults. Two such shelters existed, but the ramps leading out of them were too steep (1 in 4); consequently the guns were always left in position, and the shelters were handed over to the infantry. The shelters should be on approximately the same level as the guns, and as close to them as possible.

The artillery armament of a fort should consist entirely of guns to repel assaults. These should be small calibre—1½ inches is big enough—quick-firing guns of the latest pattern. Their duty should be to destroy bullet-proof shields and any hasty cover that the enemy may erect. In

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addition there should be a large number of machine guns. These are particularly useful for flanking ditches and the intervals between the forts. Each machine gun should have an observer allotted to it.

The proper position of the casemates for the garrison is under the gorge parapet. The casemates should each have two exits into the fort, and two into the gorge ditch. At Ehrlong—where there was only one exit into the fort and one into the ditch—both became blocked at the same moment, and the whole garrison was thus captured. In addition, there should be an underground passage, connecting the gorge casemates with the shelters under the front parapet, also an underground passage leading out of the fort; and the mouth of this passage should be thoroughly defiladed from the enemy's fire. During the bombardment of Ehrlong, the ground in rear was so swept by the enemy's fire, that it was impossible for messengers to enter or leave the fort, and when reserves were despatched to reinforce the garrison, the majority of them never reached the fort at all.

A bombproof shelter for the relief on duty must be provided under the centre of the front parapet. It should be similar to, but smaller than, the gorge casemates. An exit into the fort must be provided, and, in addition, there must be galleries connecting the shelter with the gun shelters. In the roofs of these galleries openings covered with metal shields should be provided, through which the garrison can reach the banquette.

All parts of the fort should be connected by telephones, the most important connection being that between the look-out stations on the parapet and the casemates. There should also be electric bells fitted in all the casemates and shelters, which can be rung from the look-out stations, so that the alarm may be given without delay. The exterior telephonic connections have been discussed already.

At Port Arthur the thickness of all concrete roofs was 3 feet. They were intended to be proof against 6-inch shells, and events showed that they were so. The first shell would produce a crater 4 to 5¼ inches in depth and diameter; a second falling in the same place would increase the depth by 1¼ to 2 inches, and the diameter to 2 feet; it would also detach flakes of concrete, 1 to 1½ inches thick, from the inside of the roof. More shells aggravated the damage, and produced fine cracks in the concrete. The most serious damage occurred at the edges and corners of the concrete structures. Pieces of concrete, ½ inch wide and 1½ to 2 feet long, came away at each concussion. This damage could not be repaired. On the other hand, the repairs to concrete roofs and surfaces were easily carried out, generally by covering the damaged portion with earth.

The 11-inch shells, however, pierced the 3-foot concrete roofs with ease, sometimes even without bursting. The Russians attributed this to the bad quality of the concrete, but there is no reason to suppose that this was so.

The writer calculates that where concrete is directly exposed, a thickness of 9 feet will be required to resist modern siege artillery. When an earth covering can be added, the thickness may be reduced. The effect of an earth covering is illustrated by the following examples:—

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1. At Ehrlong a 3-foot concrete roof was covered with 3 feet of earth. An 11-inch shell produced a crater only 11 inches deep, and some fine cracks in the concrete.

2. Over the covered passage at Ehrlong was a thickness of 3½ feet of earth, and over this again a bed of flints and rubbish, 6 inches thick. The 11-inch shells never reached, or damaged, the concrete. On one occasion a 6-inch shell burst in the crater formed by an 11-inch shell, but even then no damage was done.

The adoption of 12-inch and 18-inch howitzers by various European nations is likely to necessitate a further large increase in the thickness of concrete structures.

Experience at Port Arthur has shown that the most serious obstacle, to an assault, is a deep and wide ditch, with perpendicular sides. When such a ditch is flanked efficiently, it becomes impassable. Even the Japanese never attempted to make an assault across ditches of this nature. Where the ditches had been cut in rocky soil, the besieger's artillery was unable to do any appreciable damage to the escarp. There can be no doubt that the modern V-shaped ditch and steel railing is a very inferior obstacle. Even if the enemy's artillery does not destroy the railing altogether, it buries it in the *débris* brought down from the escarp and parapet.

Lieut.-Colonel von Schwartz considers that vertical escarps and counterscarps are a necessity. The escarp wall should be of concrete, and made especially thick at the top, where the enemy's shells can reach it. The ditch should be 30 feet wide, the bottom being 9 feet deeper at the foot of the escarp than at the foot of the counterscarp.—*To be continued.*

INCLINED AXES IN TELEPHOTOGRAPHY.—A discussion of the errors produced by assuming that the optical axis of the camera is horizontal, when it is actually inclined, and the limits within which such errors are negligible.

ARTIFICIAL STONE.—Some cavalry barracks and a military hospital have been built of artificial stone at Châlons-sur-Marne. The composition was 770 lbs. of Portland cement to 14 cubic feet of sharp sand and 28 cubic feet of gravel, or broken stone. For cornices the proportion of cement was increased to 880 lbs. The cost, including laying, came to 55 francs per cubic mètre, as compared with 89 to 106 francs per cubic mètre for similar work in stone.

J. E. E. CRASTER.

THE ELECTRICIAN.

January 3rd, 1908.

STREET LIGHTING BY ARC LAMPS IN THE CITY OF LONDON.—Street lighting by flame arc lamps has made great progress, the most interesting example being the experimental lighting in the City of London. Here installations of up-to-date arc lighting are being run to show the great advance that

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has been made since the days when the open type arc lamps, still in use, were first installed.

In Cannon Street, Oliver and Gilbert flame arc lamps, 28 feet high and 38 yards apart, have been used respectively for alternate lamps, and have been suspended by means of span wires, so as to hang over the centre of the street. This is undoubtedly the correct position for the lamps, both as regards efficiency and appearance, and it is likely to be adopted for future lighting.

The lamps are suspended by four span wires arranged in **X** form, and so designed that the failure of any one wire still allows a factor of safety of 7 on the remaining wire on the same side of the street. This means that ordinarily a factor of safety of 14 is adopted, and is sufficient to show that any fears as to the security of the lamps are groundless.

The four span wires are of steel, and two of them, which are insulated with rubber covered with a preservative braiding as a protection against the weather, serve to conduct the current to and from each lamp. All four span wires pass round insulators both at the lamps and at the supporting bolts fixed in the buildings. This provides insulation even in the case of wires which do not carry current, and it is so arranged that the breakage of an insulator does not take the stress off any wire.

The mean hemispherical candle-power of one of these lamps is 1,400. Current is obtained from the distributor mains, and the ordinary method adopted would be to run 10 lamps in series across 400 volts.

It is found that by placing the lamps at a high level, although the illumination in their immediate vicinity is somewhat reduced, the distribution of light is greatly improved. The minimum illumination in Cannon Street is very good, and surpasses that of any other street in London. The price—£17 10s. 0d. per flame arc lamp per annum—is cheaper than the present mode of gas lighting.

January 17th, 1908.

WIRELESS TELEPHONY IN THE U.S. NAVY.—Each of the battleships and torpedo boats, now cruising to the Pacific, possesses an installation of wireless telephones by the De Forest Radio-Telephone Co. During the preliminary trials at Fort Monroe, under the personal supervision of Dr. De Forest, messages were exchanged up to a distance of 15 miles, and, when the fleet sailed from Fort Monroe, communication was maintained up to 30 miles. Subsequent reports state that the apparatus was fulfilling expectations, and that the various orders between the vessels of the fleet were being transmitted by this means.

R. C. HAMMOND.

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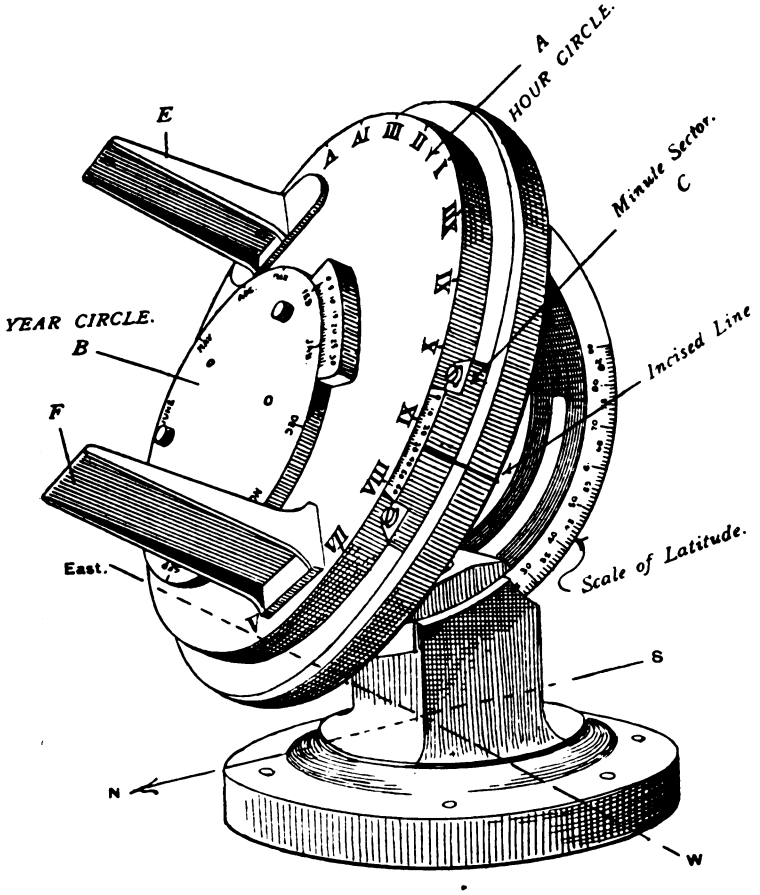
CORRESPONDENCE.

THE HELIO-CHRONOMETER.

SIR,

I beg that you will allow me, through the medium of the *R.E. Journal*, to bring to the notice of the Corps, and of your other numerous readers, a recent invention of the most interesting kind, which I have tried myself, and know to be entirely satisfactory.



It is nothing less than a sundial, which, when once set correctly, can be depended upon to give mean time correctly throughout the year whenever the sun shines (for ordinary work, of course, not for astronomical).

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The sundial in ordinary use, as is well known, does not give the "mean" time of daily life. This (the helio-chronometer) does, and, moreover, if anyone should wish to know the time of day at any distant place where a friend is, a second "minute" sector, fixed with due allowance for longitude, will enable him to read off the friend's time without any calculation.

I enclose a drawing of the instrument, and directions for adjustment can be obtained from the makers. These require little to be added by way of explanation, but I would say that the base plate shown on the sketch of the instrument must be looked upon as double, the lower part being referred to as the G.R.G. plate of the instructions; this must be first levelled and fixed firmly—the upper part is a mere collar.

The six screws pass through the upper plate into holes prepared in the lower fixed plate.

Until the screws are driven home, the instrument can be turned bodily all round the compass. When the right position is found, then screw home, and your helio-chronometer will be your comfort for ever, if you care to have your clocks keep time.

I may as well add that the upright E is the gnomon of the ordinary sundial, but instead of working with shadow, the sun passes through one of the small holes shown on it, casting a miniature of itself upon F, in the centre of which is a line, and when the spot of light is bisected by the line, the time read off from the minute sector is the correct time.

The upright or gnomon E is movable, and herein is the secret of the accurate mean time. By the studs on the year circle you move it round so as not only to bring the month under the sector 1—31, but the mark of the month under the very day. This movement shifts E also slightly, and thus the compensation is provided which ensures the mean time.

It is a beautiful instrument, highest cost at present only £10 10s. 0d., much cheaper than a chronometer, and never wants winding up, and will stand all weathers, and easily true to half a minute.

The makers are Messrs. Pilkington & Gibbs, 7, Lune Street, Preston.

Your obedient servant,

E. D. MALCOLM,

Colonel, late R.E.

The Editor, *R.E. Journal.*

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Vol. VII. No. 5. MAY, 1908.

CONTENTS.

	PAGE.
1. **Trestle Bridging.** By Capt. E. N. MOZLEY, R.E. (*With Photos*)	261
2. **Dirigible Balloons.** By Bt.-Col. J. E. CAPPER, C.B., R.E.	278
3. **A Full-Sized Portable Shovel.** By 'E.'	291
4. **Lord Cromer and Sir Charles Wilson.** By Col. Sir CHAS. M. WATSON, K.C.M.G., C.B., late R.E.	293
5. **The Survey School at the School of Military Engineering.** By Lt.-Col. B. R. WARD, R.E.	301
6. **Memoirs:**—Lt.-Gen. Sir Richard Strachey, G.C.S.I., F.R.S., late R.E. By Lady J. M. Strachey	309
Capt. Sir Henry Whatley Tyler, K.C.B., late R.E. By Col. H. E. Tyler, late R.E.	312
7. **Transcript:**—Extracts from the Sanitary Report, Hampshire Training and Manœuvre Area. By Capt. R. TILBURY BROWN, R.A.M.C.	318
8. **Notices of Magazines**	323

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CONTENTS.

Frontispiece—Field Marshal Earl Roberts, V.C. etc., etc.

1. **Cavalry on the Battlefield.** By "EQUES."
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CONTENTS.

PAGE.

1. TRESTLE BRIDGING. By Capt. E. N. Mozley, R.E. (*With Photos*) 261

2. DIRIGIBLE BALLOONS. By Bt.-Col. J. E. Capper, C.B., R.E. 278

3. A FULL-SIZED PORTABLE SHOVEL. By 'E.'... 291

4. LORD CROMER AND SIR CHARLES WILSON. By Col. Sir Chas. M. Watson, K.C.M.G, C.B., late R.E. 293

5. THE SURVEY SCHOOL AT THE SCHOOL OF MILITARY ENGINEERING. By Lt.-Col. B. R. Ward, R.E. 301

6. MEMOIRS :—

Lt.-Gen. Sir Richard Strachey, G.C.S.I., F.R.S., late R.E. By Lady J. M. Strachey 309

Capt. Sir Henry Whatley Tyler, K.C.B., late R.E. By Col. H. E. Tyler, late R.E. 312

7. TRANSCRIPT :—

Extracts from the Sanitary Report, Hampshire Training and Manœuvre Area. By Capt. R. Tilbury Brown, R.A.M.C. 318

8. NOTICES OF MAGAZINES :—

Journal des Sciences Militaires. By 'G.' 323

Revista de Engenheria Militar. By 'M.' 325

Rivista di Artiglieria e Genio. By Col. Sir Edwd. T. Thackeray, V.C., K.C.B., late R.E. 328

The Electrician. By Capt. R. C. Hammond, R.E. 336

Voĕnnyi Sbórnik. By Capt. A. H. Bell, R.E. 338

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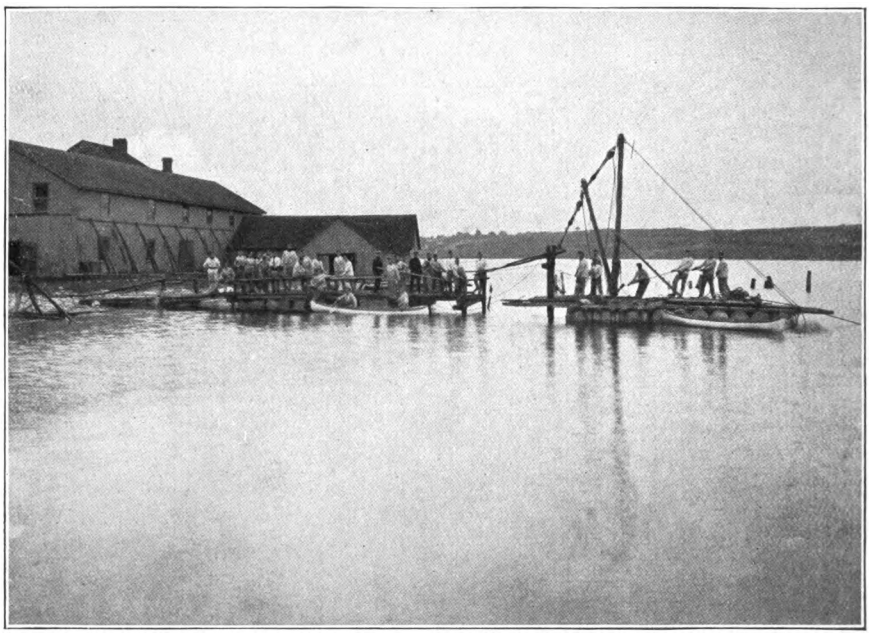
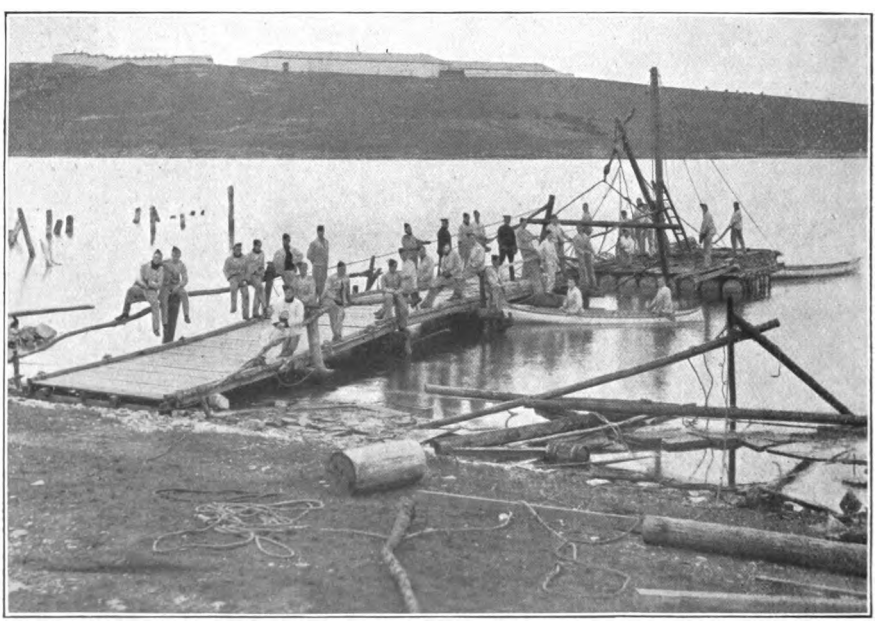
TRESTLE BRIDGING.

Launching a Trestle by Floating Derrick.





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TRESTLE BRIDGING.

By CAPT. E. N. MOZLEY, R.E.

AN apology is perhaps due for a paper on a subject with which most R.E. officers are well acquainted. It is probably enough to say that the experience here related has not elsewhere been published, and has generally been found successful. The results of experiments in a great many fieldwork and other courses are given.

There is no doubt that although increased knowledge is gained every year by individuals in their training, much of it is lost to the Corps through non-publication. It would be of great value if the new methods tried in all our fieldwork courses were systematically collected and published every year.

The use of trestles is so predominant in military bridging that any substantial advance in methods of construction and erection should be recorded. The text book, although carefully written in this branch, as in all others, has given no new information for some years.

The present article deals principally with methods of erection. This is undoubtedly the most important part of the subject, since the time of making the bridge is generally ruled by the time of placing the trestles. Trestle bridging is rarely difficult, and there are usually plenty of men to carry out the important bridges, or plenty of time to build less urgent ones. But with an army at the front time is always of the first importance. Any number of trestles can be *made* simultaneously, but they can rarely be *placed* more than two at a time. The rate of placing the trestles therefore rules the rate of building the bridge, and moreover it is in placing the trestles that such natural difficulties as exist will be found.

The parts of the subject will be treated in the order in which they are encountered in the field, viz. :—

(1). Taking the section.
(2). Construction of trestles.
(3). Organization of the bridge party.
(4). Method of placing trestles.

And notes on

(5). Rapid pile-driving.
(6). Gabion bridges.

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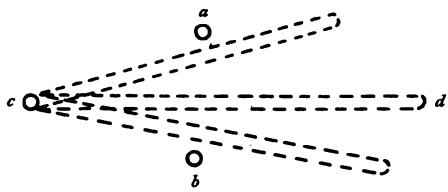
(1). TAKING THE SECTION.

The centre line of the bridge must first be marked out by two tall permanent pickets on shore, well in rear of the shore transom. Three pickets *a*, *b*, *c*, should then be driven to form a triangle in plan, as in the sketch (*cd* is the centre line of the bridge). *a* and *b* are levelled and a batten laid across them; *c* is driven to the level of the top of the batten on *ab*. A field level can then be laid as shown by the dotted lines, so as to sight on any position of a trestle leg.



This method is simpler than the use of boning rods, which are not carried on service. The readings may be taken on any pole; where the difference of level is great the pole may be slid up a 6-foot rod till its top is level with the field level. The depth of the top of the shore transom below the field level must of course be deducted from every reading.

The levels of the points where the feet rest are those required, and it must be borne in mind that the deeper the gap the further apart will be the feet of the trestle; they will be at a distance each side of the centre line of the bridge equal to $\frac{1}{2}$ (clear width of roadway + 2 feet* + $\frac{1}{3}$ difference of level between top of transom and foot of leg).

In taking a section in water the following party is needed :—

On Shore.

1 man reading heights along the field level.
1 man holding measuring tape to give distance of boat from shore transom.

In the Boat.

2 men holding the boat in position at right angles to the centre line.
1 man holding the measuring tape and an offset rod for measuring horizontal distances each side of the centre line.
1 man holding the vertical staff on which the heights are read.
Total, 6.

As soon as the difference of level between the shore transom and the surface of the water is known, all subsequent levels may be found by soundings (if the water is smooth and there is no tide) without the use of the field level.

* For ribands and thickness of legs.

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(2). CONSTRUCTION OF TRESTLES.

Material.—The text book deals principally with trestles of round spars lashed together with cordage. There would, however, be a scarcity of cordage on service, and wire would more often than not have to act as a substitute. Wire lashings can be made quite strong enough if a sufficient number of square turns, inversely proportional to the strength of the wire, be taken. The formula is as follows :—

$$n = \frac{25W}{12r},$$

where n = number of square turns to be taken,

W = maximum vertical stress which can come on the lashing (*after* reducing live load to dead),

r = breaking stress of wire used.

The formula includes a factor of safety of 5.

Instead of frapping turns a long nail may be used to twist the returns of the square lashing at each corner where they pass from one spar to the other.

It may be mentioned here that when placing the diagonals of a two-legged trestle it is advisable to have both tips on the opposite side of the legs to that on which the transom is placed (one butt being on either side); the transom can then be lowered if required without interfering with the tips of the diagonals.

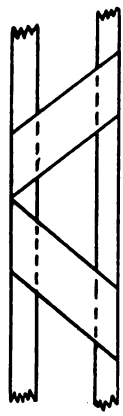
Planks nailed together make excellent material for trestles. They are light and possess no great buoyancy, and are therefore easily launched in deep water. They are also very quickly put together, and have the further advantage that their transom is easily adjustable, if the section has been inaccurately taken or if a leg sinks. The following scantlings are suitable for ordinary 9-foot roadway traffic :—

Each Leg.—Two 8″ × 2″ planks, 2 inches apart.

Transom.—Three 8″ × 2″ planks, 2 inches apart (the centre of the three planks being between those of the legs, and the other two outside of them).

Ledger.—One 8″ × 2″ plank between the planks of the leg.

Diagonal Braces (Each).—One 8″ × 1″ plank between the planks of the legs.



The planks of the legs and transom may be blocked apart at intervals, and the strength of the legs may also be increased by nailing diagonal battens as bracing, as in sketch.

If n = number of nails required between one end of the transom and a leg, then

$$n = \frac{FW}{r},$$

where F = factor of safety,

W = maximum load on one end of transom (*after* reducing live to dead),

r = mean ultimate holding power of one nail.

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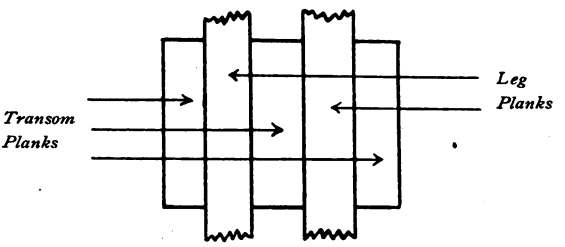
The writer carried out experiments to ascertain r. The mean was as follows :—

For 6-inch wire nails, $r=750$ lbs.
For 6-inch cut nails, $r=600$ lbs.

These values were for 1-inch planks ; 2-inch planks gave about 10 per cent. greater holding power.

If three transom planks are nailed to two leg planks, as in the sketch,



then for 15-foot bays, carrying infantry in fours, 9 or 10 6-inch nails will be needed between each end of the transom and a leg. It would be possible to use plank cleats underneath the transom if there were not a sufficient nail area otherwise. Bays for plank trestles should not, as a rule, exceed 12 feet.

When a plank trestle is put together, only the centre plank of the transom is nailed, and that lightly, so that its nails can easily be drawn, and its position altered if not at the right level when launched.

The best method of preventing trestles sinking in mud is to fit a shoe to the butts of the legs. 2-inch planking may be used for this purpose, and the area of the butt can be easily increased to 2 square feet, which will sustain a great weight in very soft mud after sinking a few inches beneath the surface.

Two-Legged Trestle with Adjustable Transom.

A two-legged trestle, whose transom is continually adjustable in a tidal river, is often needed. The Welldon trestle, which answers this purpose, is not generally available. The following method has been tried, and appears to be suitable (see *Fig.* 1) :—

A two-legged trestle is lashed up in the ordinary way, but the transom lashings consist each of two square turns and one frapping turn of 1-inch rope, instead of four square turns and two frapping turns of 2-inch rope.

Auger holes 1 inch or $1\frac{1}{4}$ inches in diameter are bored through the legs 4 feet above the highest level of the transom, the axis of the hole being parallel to the plane of the trestle.

Each end of the transom is then slung by 12 pieces of annealed wire (No. 11 gauge), which are doubled, and the bights passed round the transom outside the leg ; the 24 ends are passed through the

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auger hole, and the spare lengths wound lightly round the leg, clear of the handrail. The length to which these wire slings must be cut depends, of course, on the amount the transom will have to be lowered.

It is a good plan to allow the slings to hang well down below the transom at first, and to windlass them up *below* the transom. By loosening this windlass, the transom can be lowered more quickly than by letting out the slings through the auger holes. This method is suitable for small adjustments of levels, but for larger adjustments the slings must be paid out.

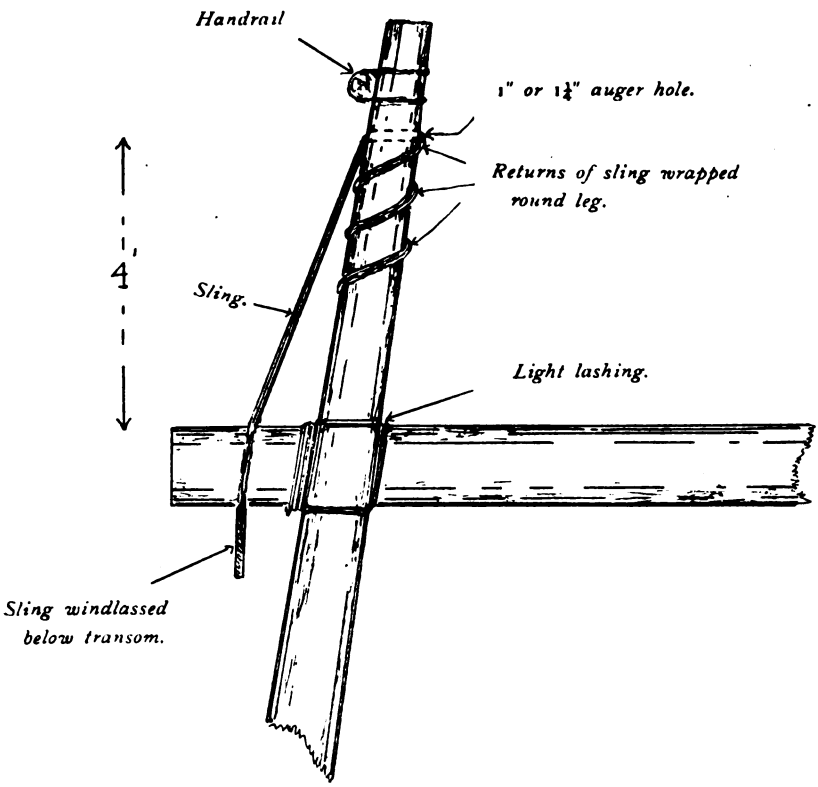

FIG. 1.—*Trestle with adjustable Transom.*

If either end of the transom is found to be too high, after launching the trestle, the weight of that end is taken by a rope made fast round the handrail close to the leg, and the windlass below slackened off. The light transom lashing is then removed, and the rope paid off till the transom has fallen to the correct level, when the wire sling is again windlassed up. The sling may be windlassed up above the transom if only a little tightening is required, but it must be windlassed below if the slackness is considerable. The rope which takes the weight can then be slackened off, and the transom lashing put on

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again lightly. The transom lashing is not essential, but gives longitudinal stability to the bridge.

If one end of the transom has to be raised, it can be done in the following manner :—

Undo the light transom lashing.
Reeve a light double and single tackle, with a 1-inch or 2-inch lashing.
Hook the double block into the lashing connecting the handrail to the leg.
Lash the single block to the end of the transom.
Hook a snatch block into the nearest racklashing, and pass the end of the fall through it.

Two men with the fall, standing *off* the bay which the transom supports, can easily raise the latter.

The strain on the fall is kept until the wire slings are windlassed up above or below the transom, or else taken in through the auger holes. The tackle is then cast off and the transom lashing replaced.

The whole of the above operation took two men six minutes.

A single block is not sufficient to raise the transom ; a tackle must be used.

This method may do away with the necessity of using tripod trestles with slung transoms in tidal rivers.

Both three-legged and four-legged trestles are most cumbrous to use, and should be avoided if possible. To launch them in deep water is almost an impossibility without a floating derrick.

Four-legged trestles are of little practical value. Their power of giving longitudinal stability to a bridge can always be obtained by the use of " fore and aft " struts or longitudinal diagonals, lashed to two-legged trestles ; moreover, they rarely rest firmly on the bottom with equal inclinations of the legs. Three-legged trestles are even more difficult to launch than four-legged. Their only real use is in tidal rivers, and in such cases they should be placed by hand at low tide.

(3). ORGANIZATION OF THE BRIDGE PARTY.

It is not possible to lay down the strict duties of each man in trestle bridging. Some such scheme as the following should, however, be worked to, in order that the various operations may proceed at equal rates. The time taken in launching can never be calculated with any exactness, and the launching party frequently requires extra help.

Organization at the Start.

A. Section party ; 6 men.
B. Shore transom party ; 3 men.
C. } Construction parties ; each of 8 men.
D. }
Total, 25.

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Duties.—For A, see p. 262.

B. Prepare the footing for the shore transom; drive four pickets to keep it in place, and two long stout pickets for the ends of the handrails.

C and D. These parties make the first two trestles, the sections for which will have been taken by the time that the materials for them have been collected.

Subsequent Organization.

E. Section party; 6 men.
F. Construction party; 8 men.
G. Launching party; 8 men.
H. Handrail and riband party; 4 men.
K. Longitudinal bracing party; 4 men.
Total, 30.

Duties.—For E, see p. 262.

F. As for C and D. The parties constructing the trestles also fix the handrails, so as to be ready when the launching party comes for them.

G. (*a*). *If Launching from the Head of the Bridge.*—Lash slide-poles to the transom of the last trestle in bridge. Fix foot-ropes. Carry up the trestle; launch it down the slide-poles and push it upright. Remove the slide-poles and lay the baulks and chesses to the trestle; the outer baulks should be lashed at each end (preferably with spunyarn) to the transoms.

(*b*). *If by Other Methods*, see pp. 267 to 275.

H. This party assists G to launch the trestle, two men being on each handrail. As soon as the feet are rightly placed and the trestle vertical, they lash their handrails to the legs of the previous trestle. They then riband down the last bay but one, and may assist to bring up planks.

K. These men fix longitudinal bracing and props between the trestles, where directed, to give longitudinal stability.

In addition to the above, a man is required in a boat to give assistance from the water, and to judge of the verticality of trestles which are being launched.

(4). METHODS OF LAUNCHING TRESTLES.

(*a*). *By Means of a Floating Derrick.*

This method was first devised by Capt. C. E. P. Sankey, R.E. It has been found to be very much the quickest and most accurate way of placing them, and practically the only way of launching them without great delay in deep water. The raft and derrick take 12 men

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four hours to build. This generally allows the derrick to be ready for use by the time the bridge has advanced into deep enough water to make its use possible. The writer has worked with floating derricks for several years, and the pattern, of which a description is here given, has been found to be a perfectly satisfactory one.

The raft on which the derrick stands is built up of two smaller rafts, X and Y (*Fig.* 2), each of three barrel piers. X has seven 40-gallon barrels to a pier; Y has nine barrels. The two small rafts are placed at right angles to each other.

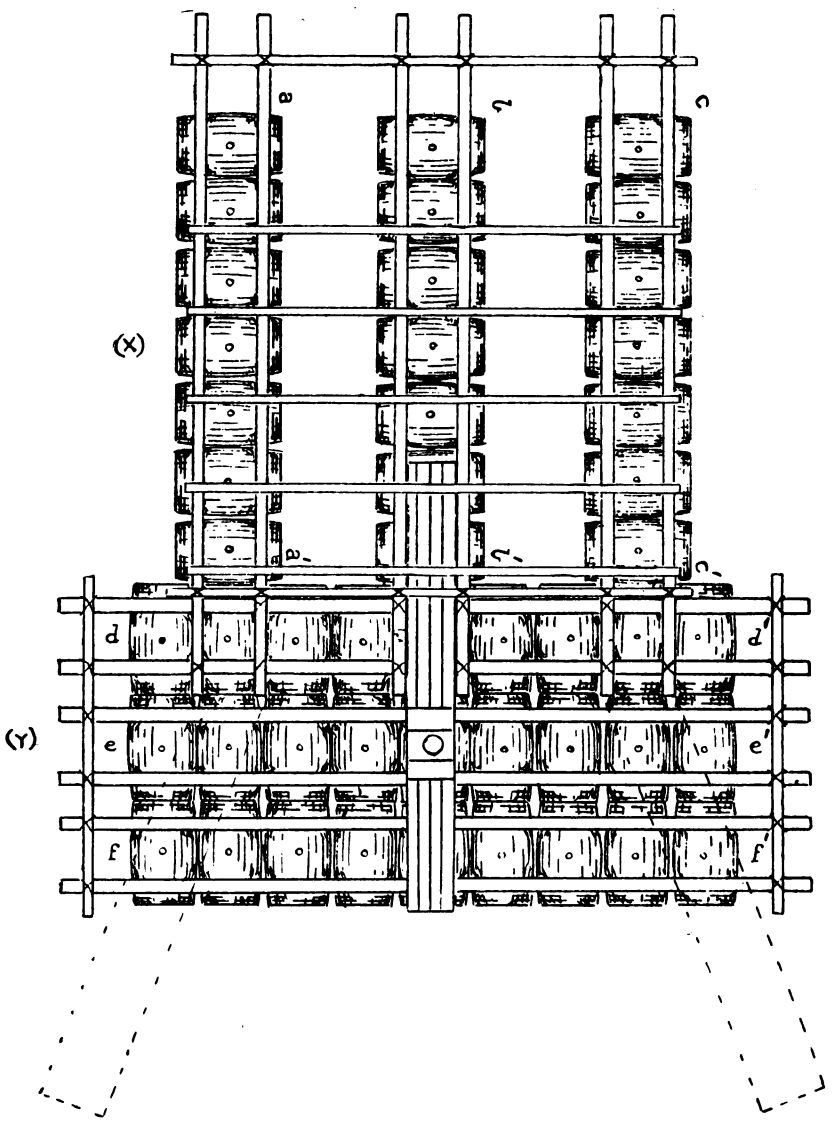

FIG. 2

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The piers *aa'*, *bb'*, *cc'* of the raft X are placed at 5-foot central intervals. The piers *dd'*, *ee'*, *ff'* of the raft Y are placed touching each other.

The piers of the raft X are connected with tie-baulks as usual. The raft Y has tie-baulks connecting the ends of its piers, and also four tie-baulks close together (or, better still, a $12'' \times 3''$ plank), placed across the centre of the raft perpendicular to the gunnels, as a foundation for the derrick. The gunnels of the pier X should have sufficient overlap at *a'*, *b'*, *c'* to rest right across those of the pier *dd'* of the raft Y. The ends *a'*, *b'*, *c'* are lifted on to the pier *dd'*, so that the gunnels of *bb'* are either side of the four central tie-baulks of Y. Blocks or wedges are inserted to give a tight fit between them, and the gunnels of X lashed to those of *dd'*. On the four central tie-baulks of Y, which form the foundation for the derrick, is placed a seating, as in *Fig.* 3. The raft X is then baulked, chessed, and ribanded. There will be a small space on the raft X (at the ends *a*, *b*, *c*), which can be chessed without baulks. The raft Y needs no baulks, but is chessed at right angles to the gunnels of the piers. Light lashings are used to hold down the chesses, instead of ribands.

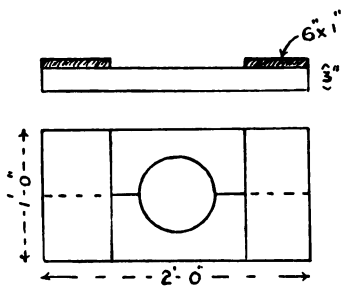

FIG. 3.

The derrick consists of a 20-foot vertical spar, $8\frac{1}{2}$ inches at centre, with a 15-foot swinging arm, 7 inches at centre. The derrick has four guys to the four corners of the raft; these may at first be of cordage, for convenience in raising, but should be replaced by wire (three-strand, No. 11 gauge, for back guys; two-strand, No. 11 gauge, for side guys). In place of fore guys, an inclined braced strut, consisting of two tie-baulks braced together, rests against the back of the derrick, 7 feet or 8 feet up, its foot butting upon one of the barrels of *bb'* (see *Fig.* 4).

The upright spar must have an initial set-back of at least 12 inches at the top, to allow for the back ties stretching when the weight comes on the swinging arm.

The swinging arm has two side guys. Two treble and double tackles are used to raise the swinging arm and the trestle respectively. The upper block of the lower tackle should be about 9 feet above the water when the slope of the swinging arm is 45 degrees.

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Two small projecting platforms (each built up of two barrel-pier baulks, 2 feet apart, centre to centre, with planking on them) are lashed as shown in *Fig.* 2, so as to project 7 feet from the raft each side of the trestle. They should have an outward splay in plan, and should be at least 20 feet apart in the clear at their outer ends, to allow room for the ledgers of big trestles to be lowered between them. They should be given a slope upwards and outwards to allow for sag. These platforms allow footrope men to have great control over the trestle. The platforms are not shown in *Fig.* 4.

The raft carries three anchors and cables and a line to attach to the bridgehead.

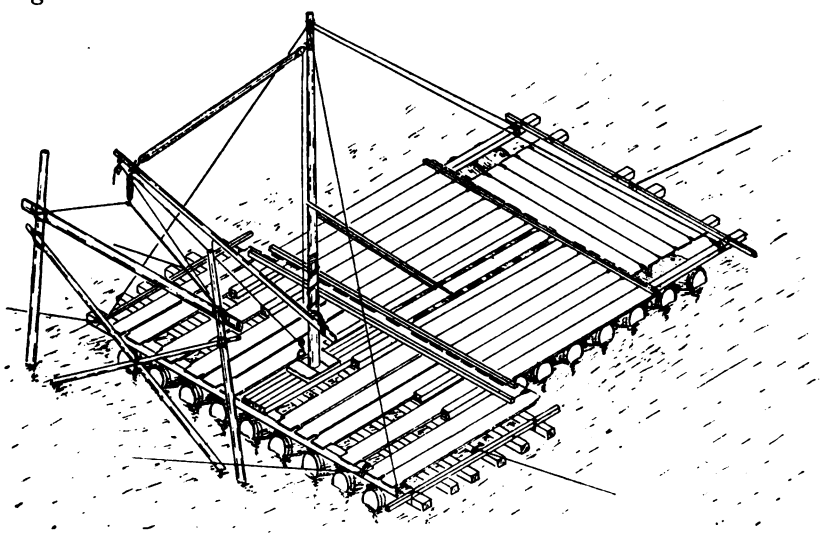

FIG. 4.

The following party is required to place a trestle with the floating derrick :—

On the Raft.

2 men in charge of anchor cables.
3 „ „ the falls.
2 „ „ the footropes to the trestle.
1 „ „ a line fastened to the centre of the transom of the trestle.

Total, 8.

On the Bridge.

2 men in charge of the footropes.
1 „ „ a line to the centre of the transom of the trestle.
1 „ „ a line from the raft to the bridge.

Total, 4.

Total party required, 12 (but large trestles have been launched by eight men with a little more time).

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Method of Launching Trestles with Floating Derrick.

The trestle, before it is put into the water, is fitted with two handrails (marked to show length of bay), four footropes, and two lines to the centre of the transom. A sling is placed over the ends of the transom, by which the trestle is raised. The raft is moored opposite the head of the bridge, and about 20 feet away from it, with three anchor cables—one offshore, one upstream, one downstream—and a line to the head of the bridge (this line need not be fixed till the trestle has been raised, unless a strong wind from the shore is blowing).

As soon as the previous trestle is in position, with handrails and road-bearers lashed, the next trestle is warped along to the head of the bridge, while the roadway of the last bay is being completed. The trestle is placed between the raft and the bridgehead, with the handrails toward the latter. The four footropes are taken in charge, two by men on the projecting platform of the raft, and two by men at the head of the bridge. The two lines to the centre of the transom are passed respectively to a man on the raft and a man on the bridge.

The lower tackle of the derrick is then overhauled till the block can be hooked into the sling of the trestle. This must be at the centre, and to ensure the hook not slipping along the sling it should be made fast by means of a blackwall hitch.

When the four footropes, two handrails, and two transom lines are in the hands of the men told off to them, those on the fall raise the trestle into a vertical position and then drop it again; the trestle, while being lowered, is kept vertical by the footropes, transom lines, and handrails. The trestle can be dropped into its exact position with great ease by manipulating the anchor lines of the raft, the line from the raft to the bridge, the side guys of the swinging arm and the upper tackle, as may be required. It has been found to be a good plan to make fast the handrails to the legs of the previous trestle at the marked points as soon as the trestle is vertical. The trestle is then under perfect control, and can be raised and slewed right or left, or the feet pulled in or out as required.

The following timetables of the launching of various trestles will show the great speed of the process. In no case had the men who carried out the work seen it done before. The party consisted of cadets in every case, except that of the plank trestle (C), which was launched by infantry officers under instruction. There was no current, but a continuous wind. The bridge was strong enough to carry infantry in fours.

A.	Four-legged	spar	trestle	in	11	feet	of water;	legs	16 feet long.
B.	Two-legged	,,	,,		13	,,	,,	,,	19 ,,
C.	,,	plank	,,		11	,,	,,	,,	18 ,,
D.	,,	spar	,,		12	,,	,,	,,	18 ,,

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	A.	B.	C.	D.
Trestle warped from shore to head of bridge,* footropes, etc. passed to men in charge of them, tackle overhauled and hooked into sling in (minutes) ...	15	30	15	Time not taken
Trestle hoisted vertically and lowered (first attempt)	17	15	9	7
Ditto ditto (second attempt)	12	15	—	—
Total time of operation	44	60	24	—

The time for B included lashing handrails and road-bearers. This case presented exceptional difficulties.

Trestles C and D were lowered into their right places at the first attempt.

Trestle C, which was lighter than the others, was launched by a total party of eight men.

Tripod trestles, 19 feet to the crutch in 12 feet of water, were also placed by the derrick. Tripod trestles cannot be kept vertical with the footropes so easily as 2-legged or 4-legged trestles, so the following device was adopted to keep the trestle vertical while lowering it (the feet were of course weighted):—

The lower tackle of the derrick was hooked into three slings connecting the three pairs of legs just above the centre of gravity of the tripod. A single block (see *Fig.* 4) was lashed to the extreme end of the swinging arm, and a line passed through this and made fast to the crutch of the tripod. By means of this line the crutch could be kept nearly vertically above the centre of the base of the trestle while lowering it. *Each* tripod takes a little longer to launch with a derrick than would a 2-legged or 4-legged trestle on the same site.

All trestles in deep water should have their feet heavily weighted before launching.

(*b*). *Launching a Trestle by Means of Rollers* (see *Fig.* 5).

The following method has been tried and has worked very well. The trestle, with its feet well weighted, is carried out along the bridge in the usual way, and is lowered until it stands just in front of the last trestle in bridge in an upright position. It is advisable to keep the trestle a few feet off the ground by making fast the footropes temporarily. Handrails are also put on.

Two large wooden rollers, smooth and stripped of bark, 3 feet long, 20 inches in diameter, are placed on the bridge, with their axes perpendicular to its centre line, and a little more than half the length of a bay from the last chess in bridge. On the top of each roller is placed a strong lever (barrel-pier gunnels, 22′ × 5″ × 4″, are suitable for

* This distance was:—For A, 40 feet; for B, 70 feet; for C, 60 feet.

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11-foot bays), and the forward ends of the levers are placed under the transom of the trestle to be launched, and are lashed to it. Men then bear down on the inshore ends of the levers, thus lifting up the trestle, and then push out on the levers, which will go forward on the rollers, carrying the trestle with them. The trestle is kept upright by means of the weight on the feet and by the handrails. Footropes and boathooks will be useful to keep the feet of the trestle down, if there is any tendency on their part to rise, but if they are sufficiently weighted these will not be needed. It is obvious that the trestle will go out twice as fast as the rollers. As soon as the trestle is the right distance out, as shown by the usual marks on the handrails, the men on the levers allow it to drop into place. By means of the levers the trestle can be "rowed" right or left to get it in the exact centre line.

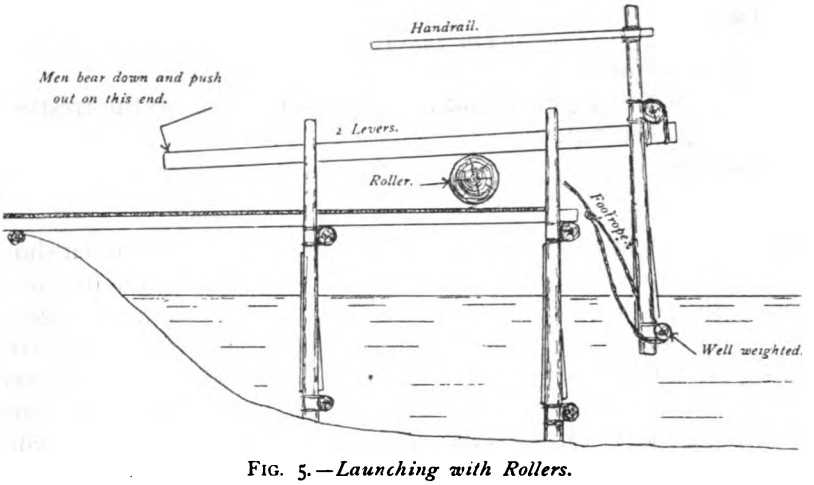

FIG. 5.—*Launching with Rollers.*

Scotches should be provided for use in front of the rollers if required.

The levers should be 2½ times the length of the bays; those only twice as long can be used for small bays.

The following party is required for launching a trestle by this method:—

3 or 4 men on each lever.
2 „ „ handrail.
1 commander of party in charge of scotches.

(*c*). *Launching by Means of a Raft.*

Probably the simplest way of using a raft is as follows:—

Suppose the raft to consist of two pontoons. Carry the trestle (without handrails) on board the raft, with the transom and ledger parallel to the pontoons, and the feet overhanging the outside of that pontoon which will be nearest the bridge when moored. Moor the raft opposite the head of the bridge, and a little more than a bay's

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distance clear of it. The raft requires an offshore cable, two lines to the bridge (one on either side), and, if there is a stream, an upstream cable. It is moored with the pontoons perpendicular to the line of the bridge. Two footropes and two back guys are then made fast to the feet and tips of the trestle's legs, and are carried back to cleats on the offshore pontoon. Two fore guys are also made fast and passed to men on the bridge.

The trestle is then easily up-ended by the following party :—

On the Raft.

Commander.
2 men, each to pay out a footrope and a back guy.
3 „ to lift ledger forward and to lift up on the transom.
1 man on offshore anchor.
Total, 7.

On the Bridge.

4 men on fore guys.
2 „ with long boathooks, or pike-poles, to move the trestle or the raft.
Total, 6.
Total party, 13.

The case might arise where no access could be had to the far shore, and it was required to connect a floating central portion to the far shore with trestles, for tidal or other reasons. In such a contingency the trestle would be put together on the floating portion. Two strong baulks, at least 10 feet apart, would be lashed down as cantilevers, hanging over the end of the floating portion towards the far bank. The trestle, with footropes and back guys on and handrails lashed to the tips, can then be slid out on these baulks, ledger leading, till the transom is close to their outer ends, and the feet are floating in the water. The handrails are then pushed out and the footropes pulled in, the tips of the legs meanwhile being lifted by men standing on planks across the overhanging baulks, and the trestle will come into an upright position. The handrails will then be made fast to part of the floating portion, and the roadway placed from the floating portion to the trestle transom.

The above operation has been carried out by the writer at Wouldham, with a rising tide, in 50 minutes (from the time the raft was anchored to the time the trestle was secured in an upright position).

(d). Launching by Means of Projecting Road-Bearers from the Preceding Bay (see *Fig.* 6).

The preceding bay must have road-bearers twice the ordinary length, so as to overlap the last trestle in bridge by the length of a bay, as CDE. They must be lashed down at C. The trestle is floated out into the position AB, A being the ledger and B the

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transom. Two handrails, of considerable length, and two foot-ropes should be fixed to the trestle beforehand. A stout plank E is placed across the ends of the cantilever road-bearers to act as a fulcrum. The feet of the trestle A are then supported by the foot-ropes from the handrails above, while they are being weighted. When sufficient weights have been fastened to the feet, the following party prepares to place the trestle :—

2 men on the handrails.
2 „ „ foot-ropes.
2 „ with levers, which they insert under the transom, using the plank E as a fulcrum to lift it up.

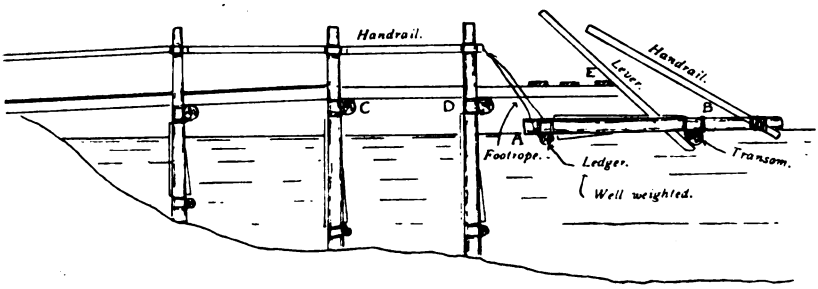

FIG. 6.—*Launching with Roadbearers as Cantilevers.*

As soon as the foot-ropes are paid off, the feet will sink. The transom is kept just beyond the ends E of the road-bearers by means of the handrails ; the levers under the transom assist to raise it.

If the feet as they sink take ground in the wrong position, the trestle can be lifted by a long lever placed under the meeting of the diagonals, using the last chess in bridge as a fulcrum. The trestle can by this means be lifted and easily " rowed " right or left.

When the trestle is in its right place, the road-bearers are slid forward a few inches and lifted on to the transom. They will probably have to be blocked up on the transom of the previous trestle.

Two guys to the tips of the trestle may be used to assist in raising it ; they will, however, have a tendency to pull the whole trestle too much towards the bridge. It has been found necessary to keep the feet A somewhat out from the bridge at the start to allow for this tendency.

(5). RAPID PILE-DRIVING.

The following method of driving light piles, similar to that described in para. 120, Part III., *I.M.E.*, has the advantage of considerable speed (see *Fig.* 7) :—

Lash a stout plank A under the last road-bearers in bridge (which must themselves be held down to the caps of the piles supporting

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them). Place long spars BC as cantilevers projecting beyond the last pile trestle a distance equal to the length of the next bay + 2 feet 6 inches. The piles are then carried out on the platform thus formed and dropped into their place between pairs of such cantilevers, which must be placed so as to enclose them. The pile is then mauled by men standing on the platform till it will stand upright by itself. The pair of spars on either side of a pile are then lashed to it; the plank A is removed, and the pile driving continued, the long spars supporting the driving party and falling with the pile.

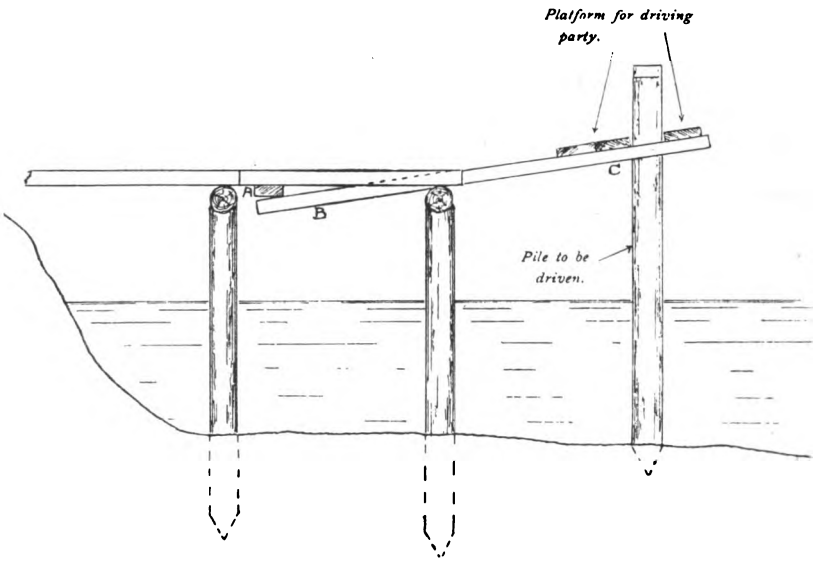

FIG. 7.—*Pile Driving with Cantilevers.*

When preparing piles, wire or thin sheet iron (Jones' iron bands are suitable) must be nailed round the head to prevent it splitting. The foot may be cut to a square pyramid with a blunt nose, and armoured with strips of sheet iron nailed over the point. If solid bottom can be reached through the mud, the feet of the piles should be cut off square.

(6). GABION BRIDGE.

Mention is made of these bridges in para. 102, Part III., *I.M.E.*, but only normal gabions, 3 feet long and 2 feet diameter, are shown in the accompanying plate. It is, however, possible to make each pier of such a bridge of specially large gabions. Where these gabions are placed upright, two are required, each having the required height; when they are placed on their side, the gabion is constructed with a diameter sufficient for the depth of the section at the point (up to at least 7 feet). The construction of such gabions presents no difficulties. It is necessary to be careful that the pickets remain parallel

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during the waling; they have a tendency to open towards the top, and it may be necessary to lash them together, which can be done without interfering with the work. The rate of building large gabions is approximately the same, per square foot of surface, as in the case of small gabions.

If they are to be used on their side, they must, if large, be fitted with internal diametrical struts of about 3-inch thickness. The gabion should, at every 3 feet or 4 feet along its axis, have three such struts, placed like a six-spoked wheel. The struts are driven through the waling, to which they must be firmly wired. If this wiring is not well done, the gabion will distort when the weight comes on it.

It is more easy to launch the gabion which is to lie on its side when in bridge than the one that is to be upright. In the former case, two inclined ways are pushed forward from the bridgehead, and the gabions rolled or slid down, with foot-ropes to guide them. Two gabions, each 6 feet long, side by side, with axes in one straight line, provide a substantial pier. The transom is lashed on the top of them.

The upright gabion is more difficult to place in position, but needs no radial struts, and is quite solid. It can be filled with stones if desired. The transom should rest on four short crosspieces, two on each gabion.

The writer has made bridges of each kind. When using the gabions on their sides, the bridge was tested with the following load:—

> 14 men, approximate weight 2,100 lbs., crowded immediately over one pier and, jumping together, produced no distortion in gabions of 4 feet, 5 feet, or 6 feet diameter.

Twenty-two men, approximate weight 3,300 lbs., similarly placed and jumping, produced no distortion in 4-foot or 5-foot gabions, but slightly flattened one 6-foot gabion, owing to the web being insufficiently wired to a strut.

An upright gabion bridge was also tested by the same weights. No failure resulted.

The gabions rested in soft mud, into which they sank very little. They are suitable for such sites where brushwood is plentiful.

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DIRIGIBLE BALLOONS.

A LECTURE DELIVERED AT THE S.M.E., CHATHAM.

By BREVET COLONEL J. E. CAPPER, C.B., R.E.

PRELIMINARY.

IN lecturing to an audience of Royal Engineer officers on the subject of dirigible balloons, I do not propose to give what may be called a popular lecture, as the daily papers and magazines give enough information on the subject to those who only take a casual interest in it, but rather to treat of the technical details, with a view to stimulating the inventive faculties of those among you who may be inclined to make a serious study of a novel and possibly a terrible instrument of war.

Numbers of people who have never even seen a dirigible balloon, much less have ever been in one, are absolutely certain that they have invented the perfect airship; and we are inundated with shoals of crude and undigested ideas from would-be benefactors, whose beneficence to the public usually entails no inconsiderable emolument for themselves.

Even when patents are taken out, such trifling details as nature of material, joints of framework, design of engine, fans and connections, etc., which give us endless thought, are all conveniently slurred over by adding the words "some suitable"; whilst not infrequently a vessel built as they propose would hardly float on water, still less in air.

I cannot too strongly impress on you that, whilst really efficient dirigibles are likely to be produced in the near future, they will not be the outcome of the sudden idea of some genius, but the result of patient labour and investigation on the part of many really practical men.

The more of us who work at it, the better will the result be; but all who work must be prepared to consider every detail of design, before any such design can hope to be of practical utility.

That you may understand clearly the problems that have to be faced in designing a practical dirigible balloon it is first necessary to explain the physical conditions which are common to all balloons.

Balloon.—You all know that a balloon itself is a vessel made of some light material which is capable of holding gas. When inflated it displaces an equal quantity of the surrounding air, and if the gas it

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contains is sufficiently light it will rise in the air. The balloon proper is technically known as the envelope.

Gas.—In order to obtain the best lifting power for a given size of balloon, in all military balloons the lightest gas available, *i.e.*, hydrogen, is used.

Envelope.—Various materials have been used for envelopes, viz., varnished cotton and silk, rubber fabric, rubber, goldbeater's skin, and even thin sheet metal. None of these, when very thin, are absolutely hydrogen tight, except goldbeater's skin and metal.

Most varnishes rot the material, and rubber perishes to a certain extent under the action of sunlight, though this action of the sun's rays can be greatly reduced by colouring the envelope yellow.

Rubber also becomes very brittle in extreme cold.

When a balloon rises the pressure of the surrounding atmosphere diminishes, and the gas inside the envelope expands. In a non-elastic balloon this expansion gives rise to great internal strains, and unless some of the gas is allowed to escape, the balloon will soon burst. In an elastic balloon, such as one of pure rubber, very great expansion can take place without danger of bursting, but the slightest puncture of the fabric will entail the immediate collapse of the entire envelope, and death to the occupants of the balloon.

Metal envelopes cannot be made strong enough to stand the strains of any but moderate elevations, without being too heavy to rise.

Fabrics are practically non-elastic.

Rubber alone is too dangerous for practical use.

Goldbeater's skin has some of the advantages of rubber, being to a certain extent elastic, whilst not subject to the disadvantage of an immediate disruption on being punctured. An envelope made of this material, therefore, allows of manœuvres between considerable differences of altitude without losing hydrogen. Any loss of hydrogen lessens by so much the capacity of a balloon to keep up in the air, and is therefore unsatisfactory.

As it may often be necessary, especially in dirigible balloons used for military purposes, to vary one's elevation considerably, it is obvious that a material which is hydrogen tight, and allows of alterations of elevation without loss of gas, has many advantages over other materials, and it is this material we are at present using for our military balloons. It is, however, subject to the disadvantage of absorbing moisture with avidity, so that in a water-laden atmosphere its weight considerably increases.

Changes of Temperature.—Changes of temperature equally with changes of altitude affect the gas, a rise of temperature causing expansion and a rising of the balloon, whilst a fall of temperature contracts the gas and makes the balloon fall. In order to keep in equilibrium during changes of temperature, rises of temperature must be counteracted by letting out gas, and falls of temperature by

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lightening the balloon. The former is effected by the use of a valve in the top of the balloon, the latter by throwing out ballast, which is usually carried in the form of sand or water.

Atmospheric conditions are rarely stable for long; difference of temperature of the air occur frequently at very moderate heights; clouds often cross the sun, causing temporary coolness; rain showers add greatly to the weight of a balloon, necessitating a corresponding loss of ballast, whilst on the subsequent drying off of the rain a corresponding rise of the balloon occurs.

As soon as all the ballast is expended, the life of the balloon in the air is nearly over, whilst the more gas one lets out, the higher must the balloon rise before the remaining gas expands sufficiently to fill it.

Loss of Gas and Ballast.—The converse is of course true, that is, in order to keep in the air for a long period of time it is necessary to lose as little gas and as little ballast as possible.

Special Difficulties of Dirigibles.—With an ordinary balloon, whether it is full or partly empty, and whatever the strength of the wind, the whole mass moves quietly along as a portion of the air current, the relative positions of the various parts remaining stable, except when sudden cross currents, or upheavals are met, which latter occur only under unusual conditions. When, however, one attempts to give a velocity of its own to a balloon, the conditions alter. The vessel then meets opposing currents, which tend to make it pitch and roll, the resistance of the air presses in its head unless this is kept rigid, and constant small eddies cause it to move to one side or another of its course.

The wind resistance on so large a body is very great, and is increased by the friction of the air rushing past the surfaces of the structure, especially if these are rough; and this resistance increases as the square of the velocity.

The average speed of the wind in England at elevations of 1,000 to 4,000 feet is believed to be about 18 miles per hour, so that in order to obtain a really practical machine we ought to get about 30 miles per hour out of it. Such a speed requires powerful and very light engines.

Moreover, whatever power is used for propulsion, this power, except in the case of stored electricity, necessitates the consumption of fuel, whilst every pound of fuel consumed (unless the products of combustion can be preserved) entails the loss of a pound of ballast, and a consequent lightening of the vessel. This loss of ballast is very considerable, *e.g.*, a 50-h.p. petrol engine will consume some 30 to 40 lbs. of petrol every hour, which is equivalent to the lifting power of 500 feet of hydrogen; so that in a 10 hours' run it will, unless otherwise compensated for, necessitate the loss of 5,000 cubic feet of gas.

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As long as a dirigible balloon remains in the air it may be looked on as being tolerably safe, both in itself, and as a conveyance for passengers. Even if the engine breaks down it is in no worse case than an ordinary free balloon. When, however, it is brought in contact with the solid ground it is a different matter. Even in light winds, unless it is very heavily overweighted, it constantly rises a few feet and drops with considerable force, so that the fragile framework containing machinery and passengers is liable to serious damage; whilst in high winds the pressure tending to tear it away is so great that even large numbers of men are incapable of holding it, and its struggles to escape become so violent that any rigid structure attached to it will be dashed to pieces.

Points Required in a Dirigible Balloon.—The points which require attention in designing a dirigible balloon are :—

(*a*). The envelope material should be

(1). Light, but strong.
(2). Hydrogen tight.
(3). Elastic.
(4). Not liable to sudden collapse if punctured.
(5). Should not absorb moisture, but should throw off rain.

(*b*). The shape should be such as to offer the minimum of resistance to the air, and this shape must be preserved.

(*c*). The envelope, car, and methods of suspension should be as smooth as possible to avoid skin friction.

(*d*). The engine must be very powerful, to give a high speed to the vessel.

(*e*). The most effective method of propulsion must be used.

(*f*). Mechanical arrangements must be made by which the balloon can be pulled upwards or downwards to compensate for temporary changes of atmospheric condition, or for loss of gas and ballast.

(*g*). Horizontal and vertical controls must be provided, partly fixed in such a way as to prevent the vessel pitching and yawing, and partly movable, so that direction in either plane can be controlled.

(*h*). Everything must be kept of the very lightest.

(*j*). It must not be possible for escaping gas from the balloon to come in contact with any spark or flame from the engine, or the result will be a disastrous explosion and destruction to the vessel and its occupants.

(*k*). Finally the construction must be such that the balloon can be kept secure from damage when landing, and safe from destruction by ordinary winds when stabled in exposed positions on the ground.

Envelope.—The material chiefly used for the envelope is rubbered fabric, an excellent gas-holder, and strong. At present we are using goldbeater's skin, but balloons made of it are expensive, difficult to construct, take long to make, and if numbers are required we shall

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have to take to other materials. It is difficult also to attach any framework to a goldbeater's-skin balloon without using a net or silk cover.

The envelope of a cylindrical balloon should be twice as strong parallel to the axis as it is on the great circle.

Shape.—Various shapes have been used, but the perfect shape is still to be obtained; a torpedo shape offers least resistance to wind pressure and skin friction, but it is not certain that this is the easiest shape to keep on its course.

The design of the rear of the balloon is as important for lessening resistance as is the design of the head; unless sloped off gradually suction is set up behind, which draws the balloon back considerably. The front may be considerably rounded without ill-effect.

Having decided on the shape, steps must be taken to preserve it. Now in an envelope of large diameter a very slight internal pressure per square inch will keep it taut. Thus if the pressure per square inch on a sphere of 30 feet diameter is 1 oz., the tearing strain per running inch of circumference is, from the formula,

$$\frac{p \times \left(\frac{\pi d^2}{4}\right) = \text{area}}{\pi d = \text{circumference}},$$

where p = pressure per square inch = 1
and d = diameter in inches = 360

$$\frac{1 \times 360}{4} = 90 \text{ oz.} = 5 \text{ lb. } 10 \text{ oz.},$$

and this strain is sufficient to stretch the fabric well.

Incidentally it is seen that the strain on the fabric for a given internal pressure per square inch is directly proportional to the diameter, so that the envelopes of large balloons have to be much stronger than those of small ones.

In order therefore to keep the envelope taut against the wind, it is only necessary to keep it at a slight internal pressure. Should the balloon, however, rise at all suddenly, or the gas grow warm, the internal pressure rapidly increases, and this is not permissible to any great extent, or the envelope would burst. Gas has therefore to be let out, and this is usually effected by automatic valves. On a descent, or on the gas cooling, the envelope would lose its internal pressure, and according as much or little gas had been let out would become more or less flabby, offering more resistance to the wind, and it might also break its back.

To overcome this difficulty it is usual to place another smaller balloon or "ballonet" inside the envelope. Air is driven into this ballonet (which is fitted with an automatic valve working at a lower

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pressure than those in the main envelope), and thus the balloon is kept distended.

The normal working pressure of fabric balloons is understood to be about 2 ozs. to the square inch, which only allows a margin of 1 oz. before gas escapes. This means that a rise of altitude of 125 feet, or a rise of temperature of the gas of $2\frac{1}{2}°$ Fahr., necessitates with non-elastic envelopes the loss of gas.

The goldbeater's-skin balloon has the advantage that it expands considerably at pressures well below the safe working strain, and if at very slight pressure on the ground, it can with safety rise to 2,000 feet without loss of gas, so that for peace practice a ballonet is not a necessity.

In order not to lose gas the balloon may ascend with the ballonet full, losing air instead of gas as it ascends. This has the disadvantage that there is considerable loss of lift at the start. It is usual to allow a ballonet of about $\frac{1}{6}$th the capacity of the balloon, so that in a balloon of 100,000 cubic feet, with a total lifting power (including the weight of the ship) of 7,000 lbs., the sacrifice of lift would amount to over 1,000 lbs. It appears preferable always to go up with as much gas as possible, losing it to compensate for loss of fuel, or, if necessary, at times to ascend to great heights. If starting for a long run in the afternoon, the balloon should be as full of gas as possible, as the gas will certainly cool at night, and air must be pumped into the ballonet, whilst the sun next day will warm the gas up and refill the balloon, so that if convenient a descent may be made in the morning for more ballast.

In some makes of airships the shape of the balloon is maintained by building a rigid framework of metal, over which some fabric is stretched, whilst inside this are placed a number of gas bags which are only partially filled. This system has the following advantages :—

(1). The outer covering maintains the general shape of the ship against resistance of air or buckling, whatever may be the state of slackness of the interior balloons.

(2). The air between the inner and outer coverings is a bad conductor of heat, and the gas is therefore little affected by changes of temperature.

(3). The rigid framework allows of great facility of attaching the car, propellers, and controls.

The disadvantages will be dealt with later.

Suspension.—The positions of the car containing engines and passengers, and of the propellers, have to be carefully considered.

In order to obtain high speed the car should be close to the balloon, as all suspending ropes cause great head resistance. If it is very close, however, it is difficult to distribute the weight of a single car over a cigar-shaped balloon, and there is some danger of escaping gas being ignited by the engine.

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It is probably better, therefore, to place the car some 12 feet or more below the balloon, using as few suspension ropes as are compatible with keeping the car from oscillating, or from too great a strain being brought on any one rope should the balloon get slack.

Various designs are used to distribute the pressure—cars extending the length of the balloon in some cases—as in the "Ville de Paris"—two cars being used in the Zeppelin balloon, and a small car in "La Patrie." On the whole the long car appears to have advantages, though it entails the carrying of some unnecessary weight.

Engine.—The engine universally used for aerial work at the present time is some form of internal combustion engine. Electrical accumulators are too heavy; the weight of fuel and water for a steam engine puts it out of court for any extended run, whilst petrol engines give a very great horse power compared with their weight, and the weight of fuel consumed is comparatively small. It may be taken as about 0·6 lb. per horse power for a well-designed engine. The quantity of lubricating oil used on a long run is also considerable; it varies greatly in different makes of engines, but cannot be neglected.

Certain French engines have a well-deserved reputation; but we are far as yet from a perfectly satisfactory design, though I am glad to say that some English makers are now attracted by the subject, and we hope to get engines in our own country which will beat anything produced by foreigners.

And here I wish to give you a word of warning. You constantly see in aeronautical journals accounts of engines which weigh as little as 2½ to 3 lbs. per horse power. These figures are very deceptive. It is true that the engine in itself may weigh as low as this, but when are added carburettors and piping (or pumps for forced carburettion), lubricating devices, pumps, radiators and water for water-cooled engines, batteries and coils, or magneto, and leads for firing, and flywheels, which are often necessary, the weight goes up by leaps and bounds, and it is found that fitted with everything except fuel necessary for a run of more than a few minutes, one of these light engines weighs at least 6 lbs. per horse power for its maximum load, whilst at the average working load it may easily weigh as much as 10 lbs. to the horse power.

Absence of vibration and economical working at low speeds are of importance, and extreme reliability is necessary in an airship engine, whilst in a military machine silence is very desirable.

Vibration tells greatly on the nerves after a time, and in the air one does not want one's nerves unduly affected.

It may often happen that the wind is blowing nearly in the direction one desires to go, and it may be economical just to keep steerage way on the ship, letting the wind do most of the work, keeping one's petrol for the stiff beat back against the wind.

As for reliability, a breakdown in the air is a calamity, and

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generally necessitates coming to ground for repairs; even the breakage of a petrol pipe, or of a small belt driving a pump or magneto, is very difficult to repair in the air with few tools and no spares handy, and only a light framework to hang on to whilst effecting the repair.

You can easily understand that one would not wish as a rule to attract attention when running near the earth in warfare, and a noisy engine can be heard for considerable distances.

The conservation of the products of combustion is very important; one form of engine, devised by Colonel Templer, enables us to keep most of these, but the engine is not light, and apparently the power is considerably reduced by the additional mechanism. This point is one that deserves very great attention, though very little appears to have been given to it. If you can invent a light and reliable method of effecting this saving, a dirigible balloon can, under favourable circumstances, be taken great distances, merely coming to earth from time to time to put out the waste products and take in fresh supplies of petrol in their place, whilst not expending its hydrogen or its ballast.

Propulsion.—The most effective method of propulsion in air has yet to be ascertained. Paddles, screw propellers, and jet propulsion have all been suggested, and many ingenious devices have been invented. It is not possible to more than touch on the subject in a short general lecture—but screws are practically the only method at present used. They cannot be said to give a very satisfactory result, and laboratory work is often very misleading. Experiments tend to prove that there is no enormous benefit gained by alterations in the curvature and shape of screws, though flat blades are not as efficient as curved ones; but a good deal depends on size of screw, rate of revolution, and proper design for the pace at which the machine will probably move through the air.

Speaking generally, it appears that large screws moving slowly are more efficient than small ones moving fast, and this is a great source of disappointment when judging from experiments made on a model scale. Thus a fan of 4 feet diameter worked by a 1½ horse-power engine may possibly give a thrust as high as 40 lbs. per horse power, but when high-powered engines are used, considerations of weight preclude making fans of proportions capable of giving the same ratio of thrust, and we have to be content with thrusts as low as 6 or 7 lbs. per horse power.

It is possible that it may be necessary to use small engines driving a number of screws, but these would require numerous drivers; or developments may be made by placing a number of screws on one shaft; but all this entails a great deal of extra weight, which we probably cannot afford.

When one considers the tremendous force required to drive a screw in the air at great speed, and the solidity which has to be

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given to both it and to the transmitting mechanism, in order to stand the strains, the useful thrust of the screw is so contemptible in comparison that it almost appears that this form of propulsion is unsuitable for bodies moving in the air. We do not yet, however, know of any better, so must adhere to it until some new method is discovered which will revolutionize our designs.

Screws.—The position of the screw propeller has to be considered. It has been placed in front as a tractor, in the centre, and at the rear, or both front and rear. In some designs it is at or near the axis of the balloon, in some a long distance away.

It is practically impossible in an ordinary dirigible balloon to get the thrust in the line of the centre of resistance to forward motion, which would be the ideal spot. With rigid envelopes it is possible to get the thrust fairly near this point, but ordinarily, with a non-rigid balloon, the screws must be some little distance below, attached to the framework of the car; and this should be so suspended that the whole system is fixed, or oscillation of the car will take place.

With a tractor screw the tendency to yaw is much reduced, and it is easier to keep the ship in horizontal equilibrium, but a considerable blast is blown back on the car.

With a screw astern steering appears to be much more difficult.

A centre screw gives fair facility for steering, but necessitates placing the car low down, so that the screw can operate between it and the balloon.

In any case the screw should not be placed so that the tips of the blades come below the car, or if on landing it touches the ground, damage to it may result.

Twin screws have advantages if placed amidships, as the car can be placed closer to the balloon. They do not appear advantageous if placed at either end, and if so placed must move in opposite directions, or they will cause the ship to describe a circle. Amidship this is immaterial.

Alterations of Elevation.—It is important to be able to raise or lower the balloon mechanically, or to resist mechanically atmospheric changes which affect the equilibrium.

This can be effected in various ways :—

(1). By shifting ballast, which by being drawn to one or other end of a long car will lower that end, and so incline the nose of the balloon upwards or downwards.

(2). By aeroplanes placed fore and aft, which can be inclined upwards or downwards, so that the head resistance of the wind will cause the whole structure to rise or fall on an even keel.

(3). By using two ballonets, one fore and one aft, so that either end of the balloon can be weighted by pumping air into one and forcing it out of the other.

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(4). By inclining the propeller screws upwards or downwards, or using horizontal screws capable of reversing, so as to draw the whole structure up or down.

The aeroplanes add greatly to the head resistance, and are only effective when the forward speed is considerable ; and the same may be said of alterations in the inclination of the balloon, whilst it is difficult to design a light but satisfactory method for inclining the propellers, and separate propellers with their mechanism add considerably to the weight.

The direct action of the horizontal propellers is very advantageous for ascending from or descending into comparatively confined situations, without loss of ballast at the start or of gas at the descent.

Horizontal and Vertical Control.—I have mentioned the pitching and yawing action of an airship when moving at speed. The vertical oscillations, if not controlled, are very considerable, most uncomfortable, and may be dangerous. Those in a horizontal plane detract greatly from the speed of the vessel.

Fixed vertical and horizontal surfaces at the rear of the vessel, or appendages, such as in the "Ville de Paris," are necessary, but the attachment of these is not without difficulty. Some attachment to act as do the feathers of an arrow is absolutely necessary. Probably a balloon so shaped that the bulk of the weight can be carried far forward is easier to steer than one of uniform shape both fore and aft from the centre. Movable controls for steering in a horizontal and vertical plane are also necessary. Ordinary rudders of tightly stretched silk can be used for these, and if the fixed controls are sufficient to keep the ship on a fairly steady course in both planes the actual steering presents no great difficulty.

However, the task of the helmsman is no light one ; he has to watch both aneroid and compass all the time, besides examining his map and the ground below. The direction of wind currents often varies so greatly at different elevations, and over different areas, that there is no means of allowing for the drift, and direction is purely guess work when out of sight of the ground. The aneroid especially requires to be closely watched, as changes of altitude take place with great rapidity, and it may be necessary to throw ballast or open an additional valve at almost any moment should the vertical controls prove insufficiently powerful.

Lightness.—The weight of all parts of an airship and its accessories must be very carefully considered. In the smaller vessels this is especially necessary, as the margin of lifting power is so small that a few additional pounds may make a great difference. With a vessel of 500,000 cubic feet capacity, the total lifting power is about 35,000 lbs., of which vessel and accessories may weigh 25,000, allowing 10,000 for passengers, petrol, ballast, etc., whilst in one of only 50,000 cubic feet the total lift is only 3,500 lbs., of which

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only 600 or 700 may be available after the dead weights are allowed for.

The propellers and their fittings must not, however, be made too light; they have to stand very heavy strains, and if one flies off it may pierce the balloon and cause a bad disaster.

Danger of Explosion.—The exhaust should be led away from the balloon, and no free sparking is permissible. The "Pax" was destroyed by the gas igniting.

Ordinarily hydrogen is so light that it will escape upwards, even from a hole low down in the balloon; but should the ballonet leak we may get an explosive mixture in it, and this being comparatively heavy may easily get down to the engine, with very disastrous results, unless sparks are properly guarded against.

Landing.—The question of keeping the balloon safe when on the ground is a very important one, if it is to be of serious utility when working with an army in the field. With a rigid balloon it is practically impossible. The balloon has a considerable momentum, and if it touches the ground at speed it may easily be so broken as to be wrecked; nor have any means been devised to keep it safe in the open on land when exposed to the force of the wind. Swatz's aluminium ship was totally wrecked on its first landing, and Zeppelin's always lands in the water, and shelters in a floating shed, so constructed that it can always enter head to the wind.

Semi-rigid balloons, as "La Patrie" and our "Dirigible No. 1," are certain to be damaged in high winds, and are most difficult to anchor.

For all field work it appears to be preferable to have a non-rigid balloon, the car of which can readily be detached from the envelope, which latter can be pegged down close to the ground, and furnished with a curtain, which prevents the wind from getting underneath it. So picketed, a cigar-shaped balloon can safely remain in the open in considerable winds, whilst the car reposes beside it.

The non-rigid system also allows of a balloon being packed and carried empty on a wagon, with the car on others, and gas compressed in tubes, so that it can be inflated if necessary comparatively close to where it is required for work.

For fortress work this question is not so material, as the vessel will return after comparatively short runs to its own shed, from which it will only issue in favourable weather.

THE USES OF A DIRIGIBLE BALLOON IN WARFARE.

I wish to say a few words regarding the probable uses of a dirigible balloon in war; and here I can only speak, of course, from theory, and do not presume to lay down the law.

It appears to me that we shall have to possess two different classes of vessels. The first will be the comparatively harmless

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small class of balloon of from 70,000 to 100,000 cubic feet capacity, to be used for scouting, and possibly for attempts at destroying, by high explosives or incendiary mixtures, important iron bridges or store depôts close to the army or fortress; or for harassing the enemy by dropping a few bombs into his camps at night, and so keeping him constantly on the *qui vive*.

It is probable that a reconnoitring balloon to be safe during the daytime will have to manœuvre at an altitude of at least 5,000 feet, from which height only large bodies and important movements would be readily visible. At night, however, a balloon can descend with safety to within a few hundred feet of the ground, and may get valuable detailed information. Even on a bright moonlight night it is difficult to see a balloon at 500 feet up, and it is very difficult to keep a search light on it. With a light wireless apparatus in the balloon much valuable information might, under favourable circumstances, be obtained, without undue risk of losing the vessel. In any case the cost of such a vessel is comparatively small, and the loss of a few would be a small matter to an army.

The radius of action of such a balloon will be, perhaps, 100 or 150 miles.

The second class (and the more important one if really seriously developed) may revolutionize the strategy of war.

Large vessels of from 500,000 to 1,000,000 cubic feet capacity, capable of travelling at a speed of 40 miles per hour in a calm, and of carrying considerable quantities of high explosives, can set out and, with a favourable wind, can cover vast distances in a few hours. When they will come, and what their objective will be, cannot possibly be known to the enemy, who cannot always be looking with guns ready pointed into the air; whilst they will pass over country so quickly as to be out of range almost as soon as seen. Keeping high up in the daytime and descending at night, they can keep their direction with practical certainty, and hovering close over any desired spot, may launch explosives with delay action fuzes, which will enable them to retire to a safe distance before the explosion occurs; or they may even risk destruction to effect some notable exploit.

Their objectives would be not the enemy's armies, but his dock-yards, arsenals, storehouses, railway centres, etc., where the maximum of damage can be caused at a minimum of cost. Possibly they might even attack the enemy's navy if he has one; but probably the same effect would be produced in a more humane manner by merely destroying the docks, etc.

There would appear to be but little difficulty in lodging the explosives with great accuracy if good plans are available to work by, whilst the expense, even should several airships be lost, would be insignificant.

Should all the Powers of the world agree that aerial warfare should

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not be carried on, then there is no necessity for us to move in the matter, though as long as those on the ground can shoot at those in the air I see no logical reason for refusing these in their turn their power of offence. But as other nations are taking up and developing their airships, we cannot afford to be behind them.

As a citizen of an island power I even welcome the airship, feeling that the idea of an invasion by an army transported in these vessels is chimerical, and that he would indeed be a bold general who would dare to transport a hostile army to our shores, crowded up in fragile transports, in the face of a serviceable fleet of dirigibles, which at the shortest notice could sally forth and deal frightful destruction among them.

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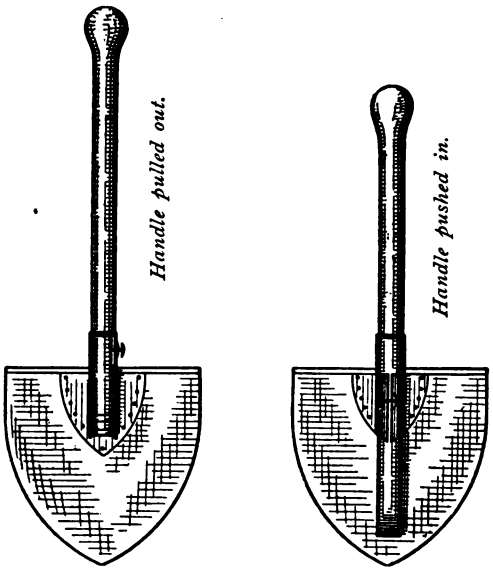
A FULL-SIZED PORTABLE SHOVEL.

By 'E.'

In an article in the *Militär Wochenblatt* of the 6th February on "Approaches in Field Warfare, and Entrenching during an Action," Major Mohr proposes a new form of portable shovel.



Front View. *Back View.*

In the first place, he proposes that the blade should be pointed, instead of rounded, at the cutting edge, as in the present German pattern; secondly, he suggests that the handle should be removable, and capable of being pushed down the blade, so as to shorten the length of the tool for carriage. To do this he would have an iron sleeve on the blade of the shovel, "cut through for half its length, and closed up by a wing or female screw."

The advantages claimed for this form are:—(1). That it is more easily portable; the blade and handle can be carried separately, or the shortened tool can be attached to the waistbelt, wood downwards, as at present worn. (2). That while a short shovel, or, at times, the iron alone, is more handy for work lying down, a long

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shaft is less fatiguing when digging standing, and both lengths are provided. (3). That, as the blade can be carried separately from the handle, a larger one becomes possible. (4). That the blade can be used stuck on its point in the ground as a shield, or, at least, support for the rifle, without being conspicuous as a shovel. (5). That the sharp point can penetrate any ground, and renders it unnecessary to carry a pick.

The rounded handle is used universally in the German Army both for full-sized and portable shovels, and is said to be less liable to give untrained men blistered hands than the T-head of the British pattern.

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LORD CROMER AND SIR CHARLES WILSON.

By COLONEL SIR C. M. WATSON, K.C.M.G., C.B., LATE R.E.

LORD CROMER'S book, entitled "*Modern Egypt*," is undoubtedly the most important of the numerous works, dealing with the history of modern Egypt, which have been published since the date of the British occupation of the country in 1882. His Lordship's complete knowledge of all the circumstances, and the wonderful work that he has done in Egypt, give an authority to everything that he says, and a weight to any opinion that he has formed which can attach to the words of no other writer.

It is, therefore, probable that a majority of the readers of his book will accept, without hesitation, the conclusions at which he has arrived as the last word which can be said with regard to the subjects of which he treats. For this reason it is all the more necessary that, in cases where Lord Cromer expresses views that are open to criticism, the public should be made acquainted also with the other side of the question. This remark applies especially to those parts of the work which treat of the abandonment of the Soudan, the mission of the late General Gordon to Khartoum, and the failure of the British Nile expedition to reach that city in time to save it from capture by the Mahdist insurgents.

With the first two of these questions I do not propose to deal in this paper, as, although they are of great importance, to treat them properly would take more space than is here available; it is, therefore, the third point to which I wish to direct attention. Lord Cromer gives an account of the origin and progress of the Nile expedition, and, having spoken of the advance of the desert column from Korti to Abu Kru, where the leader, Sir Herbert Stewart, was mortally wounded, he goes on as follows :—

"The chief command devolved on Sir Charles Wilson. At 3 p.m., on the 19th, the force advanced in square, and, after a sharp engagement, in which an attack of the Dervishes was successfully repulsed, occupied a position on the Nile a short distance north of Metemmeh. The British loss on this day was 9 officers, and 102 non-commissioned officers and men killed and wounded.

"On the following morning (the 20th) the force moved to Gubat. At 10 a.m., on the 21st, four steamers, which had been sent by General Gordon, arrived from Khartoum. They brought his journal and several letters, in one of which, dated December 14th, he said that he expected a catastrophe in the town after 10 days' time. The

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latest news was written on a small scrap of paper. It was to the following effect :—'Khartoum is all right. Could hold out for years.—C. G. Gordon.—29. 12. 84.' It was believed at the time that General Gordon wrote this so that, in the event of his letter falling into the hands of the Dervishes, they would be deceived. In reality, he was in the greatest straits. Obviously the next thing to do was to send the steamers back to Khartoum with some soldiers on board of them. It was not, however, until the morning of the 24th that two steamers, the *Bordein* and the *Telahawiyeh*, left. The interval between the 21st and the 24th was occupied in reconnaissances both up and down the river, and in making arrangements for the proper protection of the force at Gubat." And in a footnote Lord Cromer adds :—

"The delay at Gubat has formed the subject of much discussion. The conclusion at which I have arrived, after a careful examination of all the facts, is that if the steamers had left Gubat on the afternoon of the 21st, they would probably have arrived at Khartoum in time to save the town."

These words of Lord Cromer distinctly imply that he considers that Sir Charles Wilson was to blame for not starting for Khartoum on January 21st, and that, if he had done so, the town would probably have been saved. This is a serious charge to bring against Sir Charles Wilson, and, as he is not alive to answer it himself, it is incumbent on those who are acquainted with the circumstances to show ; first, that the so-called delay of three days was unavoidable, and, secondly, that it had no effect whatever on the fate of Khartoum.

It is not for the first time that this accusation has been brought against the late Sir Charles Wilson, as a similar statement was made in several articles which appeared in newspapers and periodicals soon after the fall of Khartoum. These were answered at the time, and it was proved over and over again that it would have made no difference as regards Khartoum whether Wilson had started on the 21st or the 24th January, and that no blame whatever could be attached to him for not starting on the first date. The most complete answer is contained in a book entitled "*Why Gordon Perished*," by a War Correspondent, published in 1896, which contained a careful *résumé* of the whole question of the failure of the Nile expedition. One might have hoped that the discussion upon the subject had been closed years ago, and it is to be regretted that Lord Cromer has again reopened it, and has made it necessary once more to give the reasons for believing that Wilson was entirely free from blame in the matter.

Lord Cromer has described the long delay that took place before the British Government would agree to any expedition being sent for the assistance of General Gordon ; but there are some points as regards that delay which it is desirable to refer to, especially as concerning the dates, in order to make the situation quite intelligible.

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General Gordon arrived in Cairo from London on January 24th, 1884, and, leaving for the Soudan on the 26th, he reached Berber on February 11th, and Khartoum on February 18th. While he was on the journey south, serious events had taken place in the Eastern Soudan. General Valentine Baker had proceeded to Suakin in December 1883, in command of a force, principally composed of Egyptian police, in order to relieve the garrisons of Tokar and Sinkat, which were besieged by the Dervishes under Osman Digna. On February 4th Baker advanced towards Tokar and was defeated with great loss, and on February 8th Sinkat surrendered. The British Government then decided to take steps to relieve Tokar, and on February 28th General Sir G. Graham landed at Trinkatat with 4,000 men to effect this. Tokar had fallen a week previously, but General Graham advanced, and, after defeating the Arabs at El Teb, occupied Tokar and brought the inhabitants back to Trinkitat. The British force then proceeded to Suakin and defeated the Dervishes again at Tamai on February 13th, after which an advance was commenced in the direction of Berber.

The defeat of General Baker had greatly encouraged the rebels, and had had the effect of closing the road to Berber; Gordon saw plainly that the closing of this road would have a most prejudicial effect with regard to carrying out the policy of abandoning the Soudan, and telegraphed on March 4th urging that the road should be re-opened, and that a small force of cavalry should be sent across to Berber. General Graham pointed out the importance of carrying out Gordon's wishes, and Lord Cromer pressed the British Government to allow it. But the representations of the authorities in Egypt had no effect, and on March 26th a definite order was sent to General Graham, forbidding the advance to Berber, and ordering the re-embarkation of the British troops. At that time Colonel Herbert Stewart was at Tamanib, on the road to Berber, and could have reached that place without difficulty in a fortnight. As it turned out in the end, this decision sealed the fate of Gordon and Khartoum; the road from Khartoum to Berber was interrupted in March, and in May Berber surrendered, as the garrison felt that they were abandoned.

In April Lord Cromer pointed out that an expedition would be necessary for the relief of Khartoum, but nothing was done until the following August, when Parliament was asked for a small Vote of Credit to defray the expense of a force going up the Nile. General Sir F. Stephenson, who was commanding in Egypt, was asked for his views as to the course of action to be followed, and on August 11th he proposed to send a force to Dongola at once, which was quite feasible, as the Nile was then high, and there was sufficient transport.

But the authorities in London had decided on sending the expedition up the river in boats to be specially built in England for the purpose, and the troops were kept back until the boats had been

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placed upon the Nile above the second cataract. The first boat was not ready to start from Gemai until November 1st, and by that time the river had fallen, so that navigation was much more difficult than it would have been if General Stephenson's proposal to start in August had been adopted. Lord Wolseley arrived at Korti on December 16th, two days after Gordon had written his last letter, in which he said that he expected Khartoum to fall in about 10 days. It was then arranged to send a force across the desert under the command of Sir Herbert Stewart, and the column started from Korti on December 30th, but for various reasons did not reach the Nile at Metemmeh until January 19th, 1885.

It is a little difficult to determine what proportion of the delay in proceeding to the assistance of Khartoum was due to each of the causes to which I have referred, but it is easy to calculate the total amount of delay due to them combined. As I have already explained, Sir Herbert Stewart was at Tamanib, on the Suakin-Berber road, on March 26th, 1884, and could then have reached the Nile at Berber in a fortnight, say on April 8th. But he actually did not reach the Nile until January 19th, 1885, about 9½ months later. It is remarkable that Lord Cromer does not dwell more fully on this great delay, when he implies that Khartoum might have been saved if Sir C. Wilson had started three days earlier from Gubat. But, on the other hand, it would not be an excuse for Wilson delaying three days, assuming that he had done so, because other people had delayed for 9½ months, and it is necessary carefully to consider the charge against Wilson apart from other considerations. This charge may be divided into two heads :—

1st. Was Wilson to blame for not starting on the 21st January ?
2nd. Had his not starting on that day any effect on the fall of Khartoum ?

When Sir Herbert Stewart was directed to proceed from Korti to Metemmeh in command of the Camel Corps, Sir Charles Wilson, who was chief of the Intelligence Department in the Nile expeditionary force, was ordered to accompany him, and in the orders which he received with regard to his duties were the following paragraphs :—

"I am sending Lord Charles Beresford, R.N., with a small party of seamen, to accompany Sir H. Stewart to Metemmeh, where, if there are any steamers, Lord C. Beresford will take possession of one or two of them, as he may think best. Any Egyptian (Fellaheen) soldiers on them can be converted into camel drivers, and come back here with the empty camels."

"As soon as Lord C. Beresford reports that he is ready to proceed with one or more steamers to Khartoum, you will go to that place with him and deliver the enclosed letter to General Gordon. I leave it open so that you may read it."

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"Orders have been given to Sir H. Stewart to send a small detachment of infantry with you to Khartoum. If you like, you can, upon arriving there, march these soldiers through the city, to show the people that British troops are near at hand. If there is any epidemic in the town you will not do this. I do not wish them to sleep in the city. They must return with you to Metemmeh. You will only stay at Khartoum long enough to confer fully with General Gordon. Having done so, you will return with Lord C. Beresford in steamers to Metemmeh."

It is perfectly clear, from these orders of Lord Wolseley to Sir C. Wilson, that the latter was to be simply in the position of a staff officer carrying a message from his Commanding Officer to another general. The duty of preparing the steamers for the trip to Khartoum was allotted to Beresford, not to Wilson, and the latter was to embark when the steamers were reported ready. There is not a word of any great haste being imperative, and so far from it being intended that Wilson was to relieve Khartoum, he was to inform Gordon that no steps would be taken to effect this until General Earle, who was coming up the Nile with a force in boats, had reached Metemmeh, which could not be before the second week in March at the earliest.

When the desert column arrived upon the Nile, on the evening of January 19th, it was in a somewhat broken condition; it had suffered severely in the fights with the Dervishes at Abu Klea and at Abu Kru, and a considerable number of officers and men had been killed and wounded, including a large proportion of the Naval Brigade, who had been detailed to take charge of the steamers on the Nile. Sir H. Stewart was mortally wounded; Colonel Burnaby, who was to act as Commandant at Metemmeh, had been killed at Abu Klea, and Lord Charles Beresford, who had been ordered to proceed to Khartoum in command of the steamers, was seriously ill. As Sir H. Stewart was quite incapacitated, the command of the force devolved on Sir C. Wilson, who was the next senior officer, and whose position was thus entirely altered, as from being simply a staff officer, charged with the duty of carrying a despatch to General Gordon, he became the officer in command of a force in a very difficult situation.

Although a part of the British column had arrived on the Nile late on the evening of January 19th, it had been necessary to leave the wounded and the baggage at the last camp, and the whole of the 20th was occupied in bringing these in, and in forming an entrenched camp at Gubat, near the Nile. The original orders given to Sir H. Stewart included an instruction that he was to attack and occupy the town of Metemmeh, which was two miles north of the British camp, and was strongly held by the Dervishes. Sir C. Wilson, therefore, having assumed command, decided to attempt the capture

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of Metemmeh, and, with this object in view, moved his force out on the morning of January 21st.

With reference to this operation, it is desirable to quote from the *Official History of the War* :—

"With the occupation of this village (*i.e.*, Gubat), the first part of Sir H. Stewart's mission was accomplished in spirit if not in letter. Metemmeh, it is true, had not been taken, but British troops had established themselves within two miles of it, in a defensible position, which, judging by their performances in the open, they were capable of defending against any odds. The main object of the desert march, the opening of communications with Khartoum, would apparently be capable of accomplishment the moment General Gordon's expected steamers should arrive. It now became a question whether the political effect of the capture of Metemmeh would be worth the loss of life which it would entail."

"Its possession was of considerable importance, and Sir C. Wilson decided that unless the operation proved to be more difficult than he had then reason to anticipate, the capture of the town should be attempted."

The account describes the attack on Metemmeh at considerable length, and then goes on as follows :—

"As he (*i.e.*, Sir C. Wilson) was doing so, a message was brought in from Colonel Barrow, saying that the expected steamers from General Gordon were in sight, and, before the village had been regained, a contingent of blacks and Shagiyeh, under Khashm-el-Mus Bey and Abd-el-Hamid Bey, had landed and joined the force. They were brought up by Capt. Verner, who had gone on board one of the steamers at Gubat, and were moved with their guns to open fire on the west end of Metemmeh, which it was then Sir C. Wilson's intention to attack. But hearing from Khashm-el-Mus that a large force under Feki Mustapha was on its way down from Khartoum, and might be expected at Gubat within the next 24 hours, Sir C. Wilson did not consider that he was justified, with his already enfeebled force, in risking a further loss, and accordingly gave orders to retire. During his retreat he destroyed the three villages between Metemmeh and Gubat."

It has been mentioned that Gordon's steamers arrived while the action at Metemmeh was proceeding. It might be supposed from Lord Cromer's description that they had just been sent down from Khartoum. But this was not the case; the steamers had been waiting for nearly four months, and the officers on board were almost in despair in consequence of the long delay in the arrival of the British troops. Gordon had calculated that the relief expedition would arrive at Metemmeh by the end of October, as would have been the case if Sir F. Stephenson's advice had been followed; and on the 30th September he sent four of his best steamers to

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Metemmeh with orders to wait for the English expedition. They cruised up and down the river, constantly fighting with the Arabs, and when the Battle of Abu Klea was fought, were at a point some miles above Metemmeh. As soon as they heard that the English had actually come, they moved down the Nile to Gubat.

Sir C. Wilson returned to Gubat on the afternoon of January 21st, and received Gordon's last mail from the officer in command of the steamers. It was quite out of the question that he should have started for Khartoum that night, as it was absolutely necessary that he should be perfectly satisfied as to the safety of his small force before leaving them. He had had intelligence that strong bodies of the enemy were advancing from north and south to attack the English, and he therefore decided to make a reconnaissance in both directions on January 22nd to ascertain the true position of affairs. Colonel Barrow was ordered to reconnoitre up the river, while Sir C. Wilson himself proceeded down the Nile as far as Shendy in the *Tel-el-hoween,* accompanied by the *Bordein.* I will now give a further quotation from the *Official Account of the War* :—

"During this trip it was discovered that certain repairs to the machinery were necessary, and could not be carried out until it had cooled down. On the following morning (January 23rd) they were taken in hand, and at 3 p.m. on that day Lord C. Beresford reported to Sir C. Wilson that the steamers were ready."

Even then the steamers were not quite ready to start that evening. To quote a newspaper correspondent who was present :—"As an eye-witness, the author can bear testimony to the diligence and earnestness manifested in these preparations, which were carried on with a view at first of getting the steamers off that day. It was too late to accomplish this, but all was made ready for an early start next morning."

Having regard to all the circumstances of the case, I do not think it would have been possible for Sir C. Wilson to have started from Gubat before the morning of January 24th, and it is perfectly clear that no blame whatever can be attached to him for not having started on the 21st. It is, therefore, much to be regretted that Lord Cromer should, by implication, lead his readers to suppose that the non-starting of the steamers on the 21st probably caused the failure of the effort to relieve Khartoum.

Having thus shown that the 24th was the earliest day upon which the steamers could have started, I will now give my reasons for believing that the fact of their not starting three days sooner was not a matter of the least importance so far as the final catastrophe at Khartoum was concerned. All the evidence available proves quite conclusively that the town was taken, not for want of soldiers or want of ammunition, nor by treachery, as some people tried to make out, but for the simple reason that the garrison and inhabitants

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were absolutely starved, and the soldiers were unable to make any resistance.

In the letter which Lord Wolseley received from Gordon, dated November 4th, 1884, he said that he could hold out for 40 days, *i.e.*, to December 16th, but that after that it would be difficult; but he carefully husbanded the provisions, and in a letter I received from him, dated December 14th, he said that he expected the catastrophe after 10 days. Survivors related that the last issue of rations was made about January 4th; Bordeini Bey, who had been one of the leading merchants of Khartoum, gave the following account of this terrible time:—"Soon all that had been collected in the commissariat was finished, and then the inhabitants and the soldiers had to eat dogs, donkeys, skins of animals, gum, and palm fibre, and famine prevailed. The soldiers stood on the fortifications like pieces of wood. The civilians were even worse off. Many died of hunger, and corpses filled the streets; no one even had energy to bury them."

It is really marvellous how Gordon made the place hold out for three weeks longer. At that time the river was falling rapidly, leaving a gap between the fortifications and the White Nile, but the soldiers had no strength to make new earthworks. On January 5th Omderman fell, and the Dervishes gathered closer round Khartoum. They could have entered any time they pleased, but the Mahdi waited, knowing that starvation was doing its work as surely as the sword. Then came the news of the advance of the British troops across the desert, and of the Battle of Abu Klea. The time had come to act, and as soon as word was brought that the steamers were about to leave Gubat, the order was given and the Dervishes entered the town. It was a massacre rather than a battle; the soldiers, dying of hunger, could make no effective resistance, and in a short time all was over. It would have made no difference if the steamers had left Gubat three days earlier; Khartoum would have fallen three days sooner, that is all. The game was played out before the British troops reached Gubat, and after January 20th nothing could have saved the town. The expedition failed because it started too late and took too long on the road to Gubat, and it is most unjust to the late Sir C. Wilson to imply that he was in the smallest degree responsible for the fall of Khartoum and the death of Gordon, when he, like Gordon himself, "tried to do his duty."

C. M. WATSON.

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THE SURVEY SCHOOL AT THE SCHOOL OF MILITARY ENGINEERING.

By LIEUT.-COLONEL B. R. WARD, R.E.

PREVIOUS to 1833, cadets who had qualified for commissions from the R.M.A., Woolwich, and who desired to enter the Royal Engineers, had to attend a course of instruction in Survey under the superintendence of the Director of the Ordnance Survey.

While going through this course cadets were designated "Candidates for the Royal Engineers," and on the completion of the course, they were gazetted to the Corps as vacancies occurred.

"In the autumn of 1832 it was decided that the Survey Course of the candidates for the Royal Engineers should be removed from the superintendence of the Director of the Ordnance Survey, to that of the Director of the Royal Engineer Establishment at Chatham; and in February, 1833, that decision was acted upon, Lieut. W. T. Denison being ordered to Chatham to take charge of that branch of instruction. Those cadets who were appointed to the Engineers, were still to continue as cadets under his immediate command, until their Survey Course was completed.

"The earnestness with which he took up the subject is shown by the fact that the transit instrument and the altitude-and-azimuth instrument, now in the Observatory at Chatham, were purchased by himself for use in his instruction, and were left by him, while still his property, for the use of his successor, on whose recommendation they were subsequently purchased by the Government. While he was there they were placed under two very small wooden huts, which after a few years were removed to make way for the present permanent building. He must, however, be regarded as the founder of the Observatory, a necessary adjunct to the English School of Military Engineering, but which, without the comprehensive view of his subject, taken by Lieut. Denison in 1833, would most probably never have been given to it."*

The Observatory originally stood at the south end of the R.E. Drill Shed, on the opposite side of the road to the main entrance of the S.M.E. Workshops.

* "Memoir of Lieut.-General Sir William T. Denison, K.C.B.," by Major-General Harness, C.B., in *R.E. Professional Papers*, 1872, Vol. 20, New Series, page xi.

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At the time when Colonel Warren was Instructor in Survey it was taken down, and rebuilt near the top of the Inner Lines, and in 1904 it was again taken down, and rebuilt at the back of the R.E. Institute, the work being carried out by a class of bugler boys under instruction in the workshops.

At first Lieut. Denison's work appears to have been confined to the instruction of cadets from Woolwich, who had been sent to Chatham as "Candidates for the R.E." In 1835, surveying was added to the R.M.A. Syllabus, and cadets were no longer sent to the R.E. Establishment at Chatham. An advanced course for officers would, however, appear to have been instituted at Chatham simultaneously with the withdrawal of the cadets.

From the "Abstract of Orders for the Officers doing Duty at the Royal Engineer Establishment, Chatham," issued by Sir Frederick Smith, when Director in 1847, it would appear that the Survey Course included reconnaissance, sketches, and reports, besides chain survey of detail between fixed trigonometrical points. Attendance at the Observatory for astronometrical observations also formed part of the course.

In the *Synopsis of the Course of Military Instruction at Chatham*, published in January, 1853, by Colonel Harry D. Jones, Director of the Royal Engineer Establishment, the last seven pages (60 to 66) are devoted to details of the "Course of Practical Survey and Astronomy," as taught to the officers, and to the "Instruction in Surveying," as taught to the men of the Royal Sappers and Miners.

The following is the general description of the officers' course :—

"The Course of Survey Instruction, in which the junior officers of the Royal and Honourable East India Company's Engineers are taught and practised at the Royal Engineer Establishment, is intended to be such as shall fully qualify them for carrying on survey operations—either for general purposes, such as occasion may demand, whether on Home service or in the Colonies, but which may be considered as perhaps more especially applicable to the latter—or for military purposes, as reconnaissances, or sketches of positions, etc., on active service in the field—or for special purposes, as the purchase and sale of lands, the framing of plans for the purpose of laying out towns or fortresses (in which the practice of contouring forms an essential part)—or, finally, for taking part in the operations of the Great National Survey, under the Ordnance, or of the Indian Survey, under the Indian Government; and the Course is embraced under the following general heads, viz. :—Trigonometrical and General Surveying, including topographical plan drawing, hand sketching, levelling, special surveying and contouring of ground, Military Reconnoitring, Barometrical Measurements, and Practical Astronomy" (page 60).

The following were the principal subjects taught to such men of

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the Royal Sappers and Miners as were, "by their requirements and abilities, considered likely to prove themselves useful on the Ordnance Survey of Great Britain" :—Arithmetic, Mensuration, and Logarithms, Form of Field Book and Plotting, Chain Surveying, as practised in the Ordnance Survey, Traversing with a Theodolite, Levelling, Drawing a Fair Plan and Contouring.

When Capt. H. Y. D. Scott first occupied the position of Instructor in Survey (1855–1865) the course occupied only about six weeks.

In 1860, when Sir Henry Harness took up the appointment of Commandant of the School of Military Engineering, the course of survey for the junior officers occupied about five months, out of a total of 18 months spent under instruction.

Only one officer was employed as Instructor in Survey, and Sir Henry Harness pointed out that the number of officers to be instructed was far too great for one officer to carry out the work efficiently.*

As a result of this recommendation an Assistant Instructor was appointed shortly afterwards.†

Sir Henry Harness, as Director of the R.E. Establishment (1860–1865), did much to promote efficiency of instruction at the S.M.E., and the system he introduced was carried on by Sir Lintorn Simmons (1865–1870).

In 1868 the Survey Course for officers lasted for six months.

The course was divided into two parts :—

The first part consisted of instruction in survey processes generally. Instruction in taking astronometrical observations occupied the first days of the course. This was followed by the measurement of a base line with a chain and a 5-inch theodolite.

This measured base was extended by means of triangulation over some 10 square miles of country, the detail of a portion of this area being afterwards filled in by means of theodolite traverses and observations with a prismatic compass and portable level.

This was followed by the chain survey of a small tract of country, about half a square mile in area, contours being inserted, and areas of enclosures calculated. A military sketch of some 6 square miles of country was next undertaken.

A base line in this case was measured by pacing, and the triangulation effected by means of a box sextant. The detail was put in by means of prismatic compass observations and pacing. The second part of the course consisted of the application of the knowledge gained in the first part of the course to military and civil engineering problems.

* *Life of Sir Henry Harness*, pp. 212–213.
† *Ibid.*, p. 221.

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For instance, a fort to occupy a given site was designed, and a road or canal laid out between two given points.

The N.C.O.'s and men, whose course of instruction lasted from four to nine months, were selected from volunteers whose qualifications seemed to promise their probable fitness as surveyors.

Their course consisted of instruction in chaining, use of theodolite, Y-level, and pocket sextant; and lastly in geometrical drawing, and in drawing hill forms from sketches and from models.

Lieut.-Colonel A. A'C. Fisher, who was Superintendent of Survey when Sir Lintorn Simmons was Director, made many improvements in the Survey Course.

Lieut. W. G. Morris joined at Chatham as an Assistant Instructor in 1877, after passing the Staff College Course. Classes were taken by him for infantry officers in reconnaissance work, and the instruction in this branch of survey was placed by him on a thoroughly sound footing.

These classes were discontinued in 1900.

From 1881 to 1884, Lieut.-Colonel Warren, C.M.G., held the position of Instructor, and reorganized the system of instruction for R.E. officers. He laid great stress upon the necessity of distinguishing between military sketching, in which rapidity is the chief requirement, and surveying proper, in which accurate methods are essential, but rapidity of less moment. The present text book of military sketching inculcates this teaching.

Coast reconnaissances from Brighton to Pegwell Bay were also instituted by Colonel Warren. A few miles of coast line were reconnoitred by each officer of a batch under instruction, the various sketches being afterwards pieced together at Canterbury, where the officers assembled on completion of the work.

A course of mounted reconnaissance was also organized about this time, Lieut. Bogle generally taking charge of the work, and geological tours, conducted by Professor Green, of Leeds, were also carried out.

The geological tours were shortly afterwards discontinued, but were re-introduced again, for a short time, under Major A. O. Green (1889–1893).

The course of mounted reconnaissance formed, at one time, part of a Part II. Survey Course for officers selected for service in India. This course was discontinued in 1907, so that the time devoted to survey instruction at the S.M.E. has been reduced by 22 days.

Owing to the development, in recent years, of instruction in military sketching at the R.M. Academy, Woolwich, and the large reduction in the S.M.E. Survey Course, instruction at the S.M.E. in military sketching, has been considerably curtailed.

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The whole Survey Course now covers a period of about three and a-half months, divided up as follows :—

Subject.	Working Days.	Remarks.
(i.). Military Sketching	12	Application of Sketching to Tactical Schemes.
(ii.). Topographical Surveying...	46	Triangulation, Accurate Plane Tabling & Field Astronomy.
(iii.). Cadastral Surveying.....	18	Chain Survey and Levelling.
(iv.). Road & Railway Surveying	10	Reconnaissance, Setting Out Curves, etc.
(v.). Map Reproduction.....	4	Work of a Field Litho Section.

Subhead (ii.) includes the practical carrying out of a small survey in Wales or other suitable district.

Capt. E. H. Hills, when Assistant Instructor in Chemistry, had, in 1895, worked out a practical method of determining longitudes by photography, and it was considered desirable to still further develop the utility of photography and lithography, to the purposes of survey and of map production in the field. Hence in 1904 the War Office approved of the so-called Chemistry Schools of Printing, Lithography and Photography being brought under the Instructor in Survey.

As a result, assistance has been rendered to the War Office in getting out the establishments and equipments of field printing and field litho sections. During the manœuvres of the Eastern Command at Salisbury in September, 1907, a field litho section from the S.M.E. was attached to the staff, and was employed in reproducing each night maps showing the disposition of the troops to illustrate the Director's printed narrative. The instruction of the forces exercised was thereby considerably assisted.

Lieut. F. V. Thompson, as Assistant Instructor in Chemistry, co-operated in survey instruction, and recently designed a stereoplotter, an instrument for utilizing the resources of the camera and stereoscope in the topographical surveying of mountainous country. For small scale maps of such country, this photographic method could replace the slow method of the plane-tabler by more rapid and yet sufficiently accurate work. The distinctive feature of Lieut. Thompson's instrument is that it far surpasses any method hitherto used in the rapidity and cheapness of its map plotting from photographic views.

In 1904 Major C. F. Close, C.M.G., as Instructor in Survey, obtained authority to carry out the trigonometrical survey course for officers under instruction in a camp at Stockbury, instead of round the barracks at Chatham. The innovation of breaking fresh ground and working under practical conditions was a great advance in efficiency of instruction. This principle has since been continued.

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A second camp has been held at Stockbury, and tours have been carried out in South Wales, and in the Cumberland Lake District.

Classes of some 12 N.C.O.'s are formed annually from volunteers in the Corps. The course lasts about seven months. Only intelligent men of good character who are in possession of at least a 2nd class certificate of education are selected for this course.

These men, after completing their course, are drafted to field and fortress companies, in order to keep up the establishment of surveyors in those companies.

The annual Foremen of Works Class receive a month's instruction in the Survey School, chiefly in the use of the level and in chain survey.

Before the completion of the R.E. Institute in 1875, the office of the Superintendent of Survey and the officers' halls of study were situated in A House, Brompton Barracks, on the first floor. The Survey School was located on the floor of B House, and was principally used for training men of the Honourable East India Company's Sappers and Miners in survey duties for India.

The offices and halls of study of the Survey School are now located in the south-eastern wing of the R.E. Institute, on the upper floor.

All military manuals and instruments relating to survey have either originated in the Survey School, or the latter has had considerable influence in their production.

The following are the most important text books that have been prepared by officers in the Survey School :—General Frome's *Surveying*, revised and enlarged in 1873 by Capt. C. Warren. General Frome, as a lieutenant, had been an Instructor in Surveying at the S.M.E. from 1835 to 1840. *Notes on Astronomy*, 1902, by Lieut.-Colonel A. C. Macdonnell. *Text Book of Topographical Surveying*, 1905, by Major C. F. Close, C.M.G. This text book is a model of its kind. It co-ordinates information scattered amongst various books, and has met a much-felt want.

The utility of the Survey School in the past has not been limited to the Corps of R.E., nor even to the Army. It has furnished instruction and assistance to officers and civilians employed under the Foreign and Colonial Offices, as well as the Egyptian and various colonial governments. This circulation of experience has been valuable to the school as well as to the offices concerned, as tending to keep the instructional staff up to date, and in touch with practical work.

The Montgomerie Prize, which was originally awarded for proficiency in survey work, is now no longer given for this object; but as it was instituted in memory of a distinguished Indian surveyor and geographer, it may well be alluded to in this article.

Colonel T. G. Montgomerie, R.E. (Bengal), F.R.S., was born in 1830, and passed out first of his term at Addiscombe and winner of

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the Pollock Medal. His obituary notice appeared in the *Journal* of the 1st April, 1878, written by the most distinguished geographical author that the Corps has ever produced, Colonel H. Yule, R.E. The following is a short *résumé* of some of his principal services :—

After completing his course at the R.E. Establishment he went to India in 1851, and after a year's service with the Bengal Sappers and Miners was posted to the Great Trigonometrical Survey, a service on which he had set his heart from the first.

His earliest survey work was carried out near Attok, on the Indus, in 1853, and at Karachi (1854–55). On the conclusion of this work he was appointed to the charge of the Trigo-Topographical Survey of Kashmir, and this duty occupied the next nine or ten years of his life. As Colonel Yule points out, the great difficulty of this task consisted in its being carried out amongst the most stupendous mountain tracks in the world, the observing stations ranging between 15,000 feet to 20,000 feet in height, and the work itself consisting of a "net of geometry cast out with infinite labour and bodily fatigue over the unknown." It was, in addition, carried out in the territory of a quasi-independent prince, at the very time when the Great Mutiny of 1857 broke out, reached its zenith, and was finally quelled. From this it is easy to realize that the praise accorded to Capt. Montgomerie, for the tact and ability with which he maintained amicable relations with the court and had preserved discipline among his own large and mixed establishment, was well deserved.

In 1864 the Kashmir Survey was completed, and in 1865 he received the Founder's Medal of the Royal Geographical Society for his Himalayan work.

In 1867 Montgomerie was placed in charge of the Himalayan Survey in Kurmaon and Gurhwal, and in 1870–71–72 he temporarily officiated as Superintendent of the Great Trigonometrical Survey of India. Meanwhile his health had suffered from exposure when on the Kashmir Survey ; he was compelled to return to England in 1873, and as he was unable to return to India, he retired from the Service in 1876, dying in 1878, at the early age of 48.

The principle of extending accurate reconnaissance to the countries beyond the Indian frontier, and consequently practically inaccessible to British officers, was initiated by Montgomerie, who suggested that native surveyors be trained and employed on this duty. This suggestion was carried out, and has proved eminently successful ever since.

In 1902 the prize was instituted by Colonel Montgomerie's family, and consists, as a rule, of books of travel and exploration, etc., and is awarded for contributions to the *R.E. Journal* or *Professional Papers.*

The following is a complete list of the officers who have been employed as Instructors in the Survey School :—

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SUPERINTENDENTS OF SURVEY.

Lieut. W. T. Denison	1833-1835
„ E. Frome	1835-1840
„ H. D. Harness	1840-1844
„ J. G. McKerlie	1844-1855
Capt. H. Y. D. Scott	1855-1860

INSTRUCTORS IN SURVEY.

Capt. H. Y. D. Scott	1860-1865
Lieut.-Colonel A. A'C. Fisher ...	1865-1870
Capt. F. E. Pratt	1870-1875
Major C. N. Martin	1875-1879
„ M. Lambert	1879-1881
Lieut.-Colonel C. Warren, C.M.G. ...	1881-1884
Capt. J. du T. Bogle	1884-1889
Major A. O. Green	1889-1893
„ C. W. Sherrard	1893-1896
„ A. C. Macdonnell	1896-1902
„ C. F. Close	1902-1905
„ E. P. Brooker	1905-

ASSISTANT INSTRUCTORS.

2nd Capt. W. D. Marsh	1860-1865
Lieut. C. H. Craigie-Halkett	1865-1872
„ A. Featherstonhaugh	1872-1873
2nd Capt. J. Fellowes	1872-1877
Lieut. R. A. Livesay	1873-1879
„ W. G. Morris	1879-1882
Capt. J. du T. Bogle	1879-1883
Lieut. C. B. Mayne	1882-1886
„ W. F. H. Stafford	1883-1888
Capt. W. A. Gale	1886-1889
Lieut. C. W. R. St. John	1888-1893
„ A. E. Haynes	1889-1894
„ C. H. Enthoven...	1893-1898
„ A. E. G. Watherston	1893-1898
„ W. J. Johnston	1898-1901
„ A. J. Woodroffe...	1898-1901
„ C. J. Heath	1901-1904
„ C. Russell-Brown	1901-1905
„ F. V. Thompson (Assistant Instructor in Chemistry) ...	1904-1908
„ G. F. Evans	1904-1908
„ L. N. F. I. King	1905-
Capt. T. T. Grove (Assistant Instructor in Chemistry)	1908-
Lieut. T. N. Dunman	1908-

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MEMOIRS.

LIEUT.-GENERAL SIR RICHARD STRACHEY, G.C.S.I., F.R.S., LATE R.E.

BY the death, on the 12th of February last, of Lieut.-General Sir Richard Strachey, the Corps loses not only one of its oldest members, but one whose career of public service, lasting as it did over 70 years of active work, was one of unusual length and distinction.

Born in 1817 of a Somersetshire family, he inherited the tradition of administrative ability from both sides of his family. His paternal grandfather, Sir Henry Strachey, began a distinguished career as private and political secretary to Lord Clive when he returned to India in 1765; while his mother's father, Major-General William Kirkpatrick, served with distinction in India in various political offices, and was military and private secretary to Lord Wellesley. Richard Strachey left Addiscombe at the head of his term in 1836, and after a short interval at Chatham was appointed to the Bombay Engineers, and transferred to the Bengal Engineers in 1839. His active military service was confined to a share in the first Sikh Campaign of 1845–6, when he served on the staff of Sir Harry Smith, and was present at the Battle of Aliwal, where he had one horse killed under him and another wounded, and at the Battle of Sobraon. He was mentioned in despatches and received a brevet majority.

In his professional duties as an Engineer he was mainly employed in irrigation work on the Jumna Canal, in Bundelkhund, and on the Ganges Canal, where he commenced the construction of the head works at Hurdwar.

It was in 1856 that he first became connected with the Secretariat of Public Works, as acting Under-Secretary, and thus entered on the career of administrative work, for which his abilities were so eminently suited. The department was then in its infancy, having been created by Lord Dalhousie in 1854, under the pressure of the development of irrigation canals and railways. Sir William Baker, R.E., was the first Public Works Secretary, succeeded in 1857 by Major (afterwards Sir Henry) Yule, R.E., on whose retirement in 1862 Strachey was appointed to the office. In the meantime, during the Mutiny year, 1857, he accompanied Mr. John Peter Grant to Allahabad, the head-quarters of the temporary Lieutenant-Governorship of the Central Provinces, acting under him as secretary in all departments, and on his return to Calcutta in 1858 he was appointed Consulting Engineer in the Railway Department.

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The position of the Secretary for Public Works differed from that of the other secretaries to Government, inasmuch as there was no member of the Supreme Council possessing expert knowledge of the matters with which the Department had to deal; the secretary was brought into close personal contact with the Governor-General, and had necessarily considerable departmental power. But in Strachey's case it did not end there; under three viceroys, Lord Elgin, Lord Lawrence, and Lord Mayo, he exercised a far-reaching influence over public affairs altogether outside his special sphere. Perhaps the results of his nine years of office cannot be better summed up than in the words of his brother, Sir John Strachey, who for the greater part of the time was working beside him. "It is to him," writes Sir John in his preface to the latest edition of *India*, "that India owes the initiation of that great policy of the systematic extension of railways and canals which has been crowned with such extraordinary success, which has increased to an incalculable extent the wealth of the country, and has profoundly altered its conditions. To him is due the conception of those measures of financial and administrative decentralization which have had the most far-reaching consequences, and which were pronounced by Sir Henry Maine to be by far the greatest and most successful reforms carried out in India in his time. To his active support is largely due the initiation of the measures, which have proved of the highest value, for preventing the destruction of the Indian forests, and for their scientific protection and management. He it was who first organized the great department of Public Works, and laid the foundations of the scientific study of Indian Meteorology. . . . If the weights and measures of India are still in a condition of mischievous chaos, it is because, through the powerful influence of ignorant prejudice, the Act, which he passed through the Legislature and which is still on the Statute Book, has remained a dead letter."

Strachey left India in 1871, receiving the unusual honour of a resolution from the Government of India thanking him for his services, and after acting for a time as Director-General of Stores at the India Office, he was appointed by Lord Salisbury, in 1875, to a seat on the Indian Council. In 1877, during the vice-royalty of Lord Lytton, he was again sent to India, on a special mission connected with the purchase of the East Indian Railway, by the Government, from the guaranteed company. Before his return in 1879 he had been appointed President of the first Famine Commission, and subsequently acting Finance Member of Council in place of his brother, whom ill-health had compelled to take leave to England. In the former capacity, he laid down those principles which have guided all subsequent efforts to combat the periodical famines from which India suffers. As Finance Member he wrote a highly important minute containing proposals for a reform of the

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Indian currency, which, had they been then carried out, would have saved India from incalculable loss. Fourteen years later similar proposals were adopted as the result of the Committee on Indian Finance, presided over by Lord Herschel, of which Strachey was a member. He also acted as Military Member of Council for a short time at the beginning of the Afghan War.

Strachey was re-appointed as a permanent member to the Council of India, but resigned his seat in 1889, and accepted the chairmanship of the East Indian Railway Company, to which he devoted the remainder of his life. His energy, his wide and public-spirited views of policy, and his remarkable capacity for mastering details made his management a memorable one. Under him, the line—already, from its natural advantages and excellent management, the most prosperous in India—attained a level of financial prosperity, which alone has enabled the Government of India to reckon its railway policy as a financial success. It may be added that the increased returns to revenue have been coincident with a considerable decrease in traffic and passenger rates. His rule has been commemorated in the name of the Strachey Bridge, across the Jumna, which was opened a few weeks before his death. He was also for several years chairman of the Assam-Bengal Railway Company.

Although thus actively engaged in the public service over a length of 70 years, this was not the only field in which Strachey's abilities were exercised. He attained distinction in various branches of science, as a scientific explorer and geographer, a geologist, a botanist, and a meteorologist. He was a President of the Royal Geographical Society, and an honorary member of the Italian and the Berlin Geographical Societies. His meteorological work was specially valuable; for 22 years he was chairman of the Meteorological Committee, and received the Symons Medal from the Royal Meteorological Society. He served for a considerable period on the Committee of Solar Physics, and was for many years on the Council of the Royal Society, which awarded him the Royal Medal in 1897.

In 1884 he was a delegate to the International Congress, held at Washington, for determining the Prime Meridian, and in 1892 was also delegate to the Monetary Conference held at Brussels. The University of Cambridge conferred upon him the honorary degree of LL.D. in 1892, when the late Duke of Devonshire, a former Secretary of State for India, was appointed Chancellor.

For his public services Sir Richard Strachey was granted a Distinguished Service Reward in 1866, was made C.S.I. in 1865, and, finally, in 1897, on the occasion of the Diamond Jubilee of Queen Victoria, was awarded the well-merited distinction of a G.C.S.I.

J. M. STRACHEY.

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CAPT. SIR HENRY WHATLEY TYLER, K.C.B., LATE R.E.

WHEN asked by the Secretary of our Institute for a short memoir of his father, the writer naturally thought at first that such a memoir would come better from some brother officer who was not also a son. His father had, however, outlived most of his contemporaries, and his retirement at a comparatively early age, and previous civil employment for 15 years, had put him of late years out of touch with his old friends in the Corps. But those who knew Sir Henry will regret that the privilege of writing this was not given to someone whose pen could have done better justice to the theme.

Henry Whatley Tyler, the eldest son of John Chatfield Tyler, Esq., a Deputy Lieutenant of the County of Gloucestershire, was born in Chesterfield Street, Mayfair, London, on the 7th of March, 1827. He joined the Royal Military Academy, Woolwich, at the age of 15, and got his commission in the Royal Engineers in the shortest time possible, in December, 1844. After the usual course at the S.M.E., he was sent to Ireland for a year, and then to the West Indies. During four years in St. Lucia he added the duties of Private Secretary to the Civil Governors and Administrators of the island to those of an Engineer officer. Fond of horses from boyhood, he employed his leisure whilst in St. Lucia by training raw mustangs from Mexico. He also became a corresponding member of the Royal Zoological Society, supplying them at one time with the larger portion of their stock of snakes, and contributing a very interesting series of articles descriptive of snakes and their habits to the Society's proceedings.

On returning home after a tour through the other West Indian islands, Lieut. Tyler was one of the several R.E. officers specially employed in the great International Exhibition of 1851. And he continued in charge of a collection of permanent exhibits he had been the means of forming there, which afterwards became the nucleus of the South Kensington Museum.

In 1852 Lieut. Tyler married Margaret, the daughter of Lieut.-General Sir Charles Pasley, K.C.B., R.E., and at the same time was appointed Engineer to the Colony of Victoria. On the way to Australia all three masts went by the board in the Bay of Biscay, the rigging fouled the propeller, and the captain of the ship called the passengers together and told them that the ship was unmanageable, and that he could do nothing more for them. Fortunately the passengers were of better metal, and they organized themselves and cut away the wreckage, and the ship eventually reached Lisbon. Lieut. Tyler sailed twice more, the ships breaking down on both occasions, and on return from his third attempt he was offered, and he accepted, the appointment of Government Inspector of Railways under the Board of Trade. His brother-in-law, Capt. Charles Pasley, R.E., took up the colonial appointment in Victoria.

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In 1868, when within three months of his lieutenant-colonelcy, Capt. Tyler was retired from the Corps of Royal Engineers without pension, under regulations then in force; as these regulations were altered shortly afterwards in regard to military officers holding civil employment, he was the only officer to whom they were thus applied.

From 1853 to 1877 Capt. Tyler was continuously employed in inspecting new railways, reporting on railway accidents, enquiring into complaints of Metropolitan water supply, and a host of special services in the United Kingdom and on the Continent. In 1865 he read a paper on "The Festiniog Railway" at the Institution of Civil Engineers, and in the same year made experiments with Mr. Fell's third-rail system, with a view to its adoption on the Mont Cenis. In 1866, 1867, and 1869 he examined and reported on the means of accelerating communication with India, after three visits to the various ports of Italy, and careful examination of the different routes to them through France and Italy, which led to the adoption of the Brindisi route for the Indian mails.

In addition to all his railway and other work Sir Henry invented in 1853 the galvanized sheet-iron gabions, afterwards modified by Sergt.-Major Jones into iron-band gabions (*R.E. Professional Papers*, Vol. VIII.). He wrote many articles for the *Quarterly Review*. He read papers at the Royal United Service Institution—in 1858 on "The Effect of the Modern Rifle upon Siege Operations and the Means Required for Counteracting It"; in 1859 on "The Rifle and the Spade, or the Future of Field Operations"; in 1860 on "The Principles of Fortification advocated by Mr. Ferguson"; in the same year on "The Rifle and the Rampart, or the Future of Defence"; in 1864 on "Spithead and Harbour Defence"; in the same year on "Railways Strategically Considered"; and in 1866 on "Routes of Communication with India." In 1859 he contributed a paper on "The Probable Influence of the Modern Rifle in the Field, and the Necessity for an Increased Use of Entrenchments in Future Field Operations" to the *Corps Papers*. In 1862 he wrote a memoir of Sir Charles Pasley for the Royal Society of London (Vol. XII.).

Sir Henry Tyler continued to discharge duties, which would have overwhelmed many a younger man, with all his usual care and skill until within a week of his death on the 30th of January, 1908, a few weeks under 81 years of age. His last public speech was to the Peruvian bondholders, as chairman of the Corporation, on 31st December, 1907, a speech of three-quarters of an hour's length, fully explanatory of the new agreement between the Corporation and the Government of Peru, composed with all his customary lucidity, and clearly audible through the hall.

In 1867 Capt. Tyler spent his leave making an inspection of the Grand Trunk Railway of Canada, and also read a paper at the Institution of Civil Engineers on "Railway Gradients and Curves." In 1868

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to 1869 he spent his leave constructing the first railway in Greece, between Athens and the Pyraeus, and hired six brigands to police the line. He opened this railway in March, 1869, and enquired into the means of communication between England and France on the way home.

He was next chairman in 1875 and 1876 of the English Channel Tunnel Commission, whose meetings in Paris and London, with the French Commission, resulted in a treaty between the two countries. So far from regarding such a tunnel as a menace to our insular isolation, he held that if only we could induce a hostile army to enter a pipe 30 miles long and 30 feet in diameter, it would be worth while spending three millions on the construction for that sole purpose.

From 1871 to 1877 Capt. Tyler was Chief Inspector of Railways at the Board of Trade, and his annual reports, published as Blue Books, on railway statistics and railway accidents became text books of great value, and were studied and quoted in all civilized countries. They contributed materially to the general improvement of, and rapid adoption of modern appliances on, the railways of this country.

In 1871 he gave a series of four lectures at the S.M.E. on railways; made another inspection of the Grand Trunk in Canada, and of the International Bridge over the Niagara River; and in the same year made a second report on the Metropolitan water supply, and served on a Board of Trade Commission to settle regulations for the water companies. In 1872 he gave evidence before the Select Committee on the Euphrates Valley Railway scheme. In 1874 he inspected the Erie Railway and its connections, and a paper he wrote on "Simplicity as the Essential Element of Safety and Efficiency in the Working of Railways" was read in his absence by Colonel Yolland, R.E., at the Society of Arts.

In 1875 there was a debate in Parliament on the propriety of Capt. Tyler being allowed to spend his leave inspecting railways in European Turkey, at the request of the Turkish Government, through the Foreign Office. The President of the Board of Trade, defending his action, stated that Capt. Tyler had already started. With his colleagues, he inspected about 900 miles of railway in Roumelia, and from Salonica to Mitrovitza, and afterwards, at the special request of the Grand Vizier, Essad Pacha, rode on horseback for about 400 miles through Bosnia, which he described as "like hunting for a whole fortnight, with sundry adventures thrown in." Bosnia was at the time seething with revolt, and he called it "a country of mountains without the usual intervening valleys." He wrote his report in French, and got back inside his two months' leave.

In 1877, at the request of Mr. Westinghouse, Capt. Tyler became chairman of the Westinghouse Brake Company in England. The post was of course incompatible with continuance in his appointment at the Board of Trade, and accordingly he resigned after serving as an

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Inspector of Railways for 24 years, of which he was Chief Inspector for seven. As he had not attained the age of 60, he was again refused a pension, and claimed to be the only instance of a public servant who had given his best work to his country for 33 years without becoming a burden to her in his age. He received, however, the honour of knighthood for his services.

The unstinted praise of all the newspapers on Sir Henry's retirement everywhere prove the thoroughness of all his work, and that the additional duties which he undertook, concurrently with his duties in the Board of Trade, in no way interfered with them. The Executive Council of the Amalgamated Society of Railway Servants passed the following resolution in 1877 :—"That this council has heard with regret of the retirement of Capt. Tyler, R.E., from his position of Chief Inspector of the Railway Department of the Board of Trade, and expresses its admiration of the faithful and fearless manner in which he discharged his arduous duties many years, to the advantage and greater safety of the public and of railway servants. This council also tenders its best thanks to Capt. Tyler for his invariable courtesy to railway servants, and to representatives of the Amalgamated Society present at his numerous official enquiries."

Among the reforms in railway conduct for which he had fought most strenuously were extensions of stations and sidings, wide and clear platforms, continuous footboards which should fit the platforms, footbridges or subways at crossings and in stations, and continuous automatic brakes.

So much was Sir Henry's name before the public a generation ago that he was known by his works in all parts of the civilized world, and the *Globe*, in a leading article of December 9th, 1876, says : " . . . Capt. Tyler once a year has a story to tell which far exceeds Aladdin and Ali Baba in the fascination of its incidents for the children of a larger growth. In his general report to the Board of Trade, Capt. Tyler reviews the whole railway system of the British Empire. A great master of style, uniting the official and statistical with the popular form of elucidation, Capt. Tyler puts into a few pages, for a few pence, more information than any writer we know . . ."

He made a practice of walking the whole length ot every new line he opened, often to the no small discomfort of the officials who accompanied him.

Already president of the Grand Trunk Railway of Canada, Sir Henry became chairman of the Rhymney Iron Company, a director of the Great Eastern Railway, of the National Mutual Assurance Co., and of the Globe Insurance Co., besides being engaged in many less known undertakings. In this year (1877) he again went over the Grand Trunk, for which purpose he visited Canada every year for the term of his presidency. With able assistance from the many excellent

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officers of the company, he built up the Grand Trunk into a system which has been very beneficial to the country it serves. The international tunnel under the St. Clare River, between Sarnia on the Canadian side and Port Huron in the United States, remains a lasting monument of his presidential enterprise. It is 3,851 yards long, including approaches, and was made under the compressed air system through about the worst material possible, a mixture of sand and clay. The air pumped into the tunnel during boring appeared at all sorts of places on the river surface, up to a quarter of a mile away from the site.

In 1877 to 1878 Sir Henry spent three months visiting and reporting on the railways of the colony of the Cape of Good Hope, of which Sir Bartle Frere was then Governor. Incidentally the Zulu War broke out during this visit, and Sir Henry, himself unarmed, took an armed Zulu prisoner, and confiscated his rifle. He advocated that we should reorganize the intelligence system, and set ourselves the task of capturing chiefs by flying columns, as a means both of quelling and preventing native revolts.

Sir Henry Tyler sat in Parliament as member for Harwich from 1880 to 1885, when the borough was merged into a county division; and for Great Yarmouth from 1885 to 1892, being then defeated at the general election. A staunch Conservative, he was rather too independent in character to make an ideal pawn in the party; and he welcomed the relief from attendance at the House, and refused invitations to contest other constituencies.

As a boy equally successful in his classical and his mathematical studies, General Wrottesley very kindly writes of him: "He entered the R.M. Academy at the earliest age a cadet could enter in 1842, for he had only just completed his 15th year. He passed out as an officer of Engineers in December, 1844, when he could have been very little over 17 years of age, and I think you will find he was the youngest officer who ever entered our Corps. As a cadet he was remarkable for the energy he put into everything he undertook, and the quickness and accuracy of his work. I sat next to him in the fortification class, and the neatness and rapidity of his drawings were always a source of envy and marvel to me. He carried the same qualities into all his work in after life, and it was the secret of his success. He combined great energy in action with lucidity of thought and clearness of judgment. These were qualities which would have led him to distinction in any walk of life, and I always regretted for that reason that he relinquished the public service. He gave up in fact to commerce what was meant for his country and his Corps."

A great reader of newspapers, a careful student of all scientific progress and discovery, all things were real to him. He had at his command an enormous fund of anecdote and a keen sense of humour.

There was an extraordinary contrast between his character and the

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popular conception of a financier. With all the business and appointments he obtained, he never sought any. He was constantly declining offers, and many things which he accepted he took only because they were thrust upon him. As a director of public companies, if the company were in financial straits he would often forego his salary and give his services free till better times. He made mistakes in some cases, but frankly owned them. He was occasionally swindled, but he never led others into losses. Presiding as chairman at a company meeting in the case where a very interested opposition had been successful and obtained a vote contrary to the Board, amid cries of "Resign" Sir Henry, on one memorable and unique occasion, declined to resign, and before the next meeting the scheme was exposed, and collapsed. He continued in the chair of that company till the day of his death.

His generosity was unbounded, but unobtrusive. He made friends everywhere, and remembered them all. He served with the same zest on committees of the London Homœopathic Hospital, to which he gave large sums, as he did on boards from which he drew salaries. He took the same intense and scientific interest in his farm in Surrey as in the business of the Peruvian Corporation, to which his last public speech was addressed.

H. E. TYLER.

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TRANSCRIPT.

EXTRACTS FROM THE SANITARY REPORT, HAMPSHIRE TRAINING AND MANŒUVRE AREA.

By Capt. R. Tilbury Brown, R.A.M.C.

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Sanitary Sections.

The system of sanitary sections was excellent; they were permanently employed, took an interest in their work, and I attribute the good results, shown during training and manœuvres in camp sanitation, to be due to the ready and intelligent manner in which they performed their duties.

The sections consisted of one non-commissioned officer and eight men from each regiment.

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The question as to *what* men should be employed as sanitary section men is left to commanding officers, some of whom have the pioneers, and others (the minority) have men from the companies.

I have been asked whether I consider the pioneers the best men to be employed.

At first sight the answer is Yes! but on consideration I think No! for the following reasons:—My idea is (1) that the sanitary section men should be permanently employed as such; (2), that they should have no other duties; (3), that they should have special training; and (4), that a certain number should accompany the regimental companies when on the march, and that the remainder should be together under the sanitary non-commissioned officer, ready to prepare the camping ground at any moment.

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Furthermore, the non-commissioned officer of the sanitary section should have sanitary authority, as far as lies in his province, over the *whole* camp or barracks, and not portions only, as is frequently the case.

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Water Carts.

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(A). *Metal.*—I consider that these carts should only be used as an extra supply for the filter carts, which might find difficulty in procuring water.

The washing-up water ought to be boiled or filtered just as much as the drinking water, but is often neglected.

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(B). *Wooden.*—I consider that these carts should be abolished; but in any case they should only be used to supply filter carts, and the above remarks apply concerning washing-up water.

(C). *Filter Carts (Field Service).—The Brownlow Patent Filter Water Carts.*—These carts produce excellent water.

I analyzed the water from five carts, and found no coli-like organisms, though in three instances they were present before filtration.

Each cart was worked by a *water-squad* of one non-commissioned officer (or senior private) and two men of the R.A.M.C. These men were attached to regiments.

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The carts were tried over very *rough country.*

They had to be dug out of bogs, were severely shaken over hidden ditches, and tested very highly. The results were good, and the carts sustained no damage, as far as I could ascertain, from the rough work, with the exception of one broken candle.

Output of Water from Carts.—When dealing with a *clear water* it was generally found that it took from 25 to 30 minutes to fill it, and the same to empty it. At this rate, and allowing the cart to be filled before commencement, the cart could supply about 100 gallons of filtered water in the first hour, and 200 gallons in 1½ hours. One trial gave 140 gallons in an hour. I do not think it possible to get 210 gallons per hour, including the necessary filling.

When *very muddy water* was used, as an experiment, from a muddy and thick stream, it was found to take 50 minutes to fill the cart, and about 30 (as with clear water) to empty it through the candles; that is to say, 80 minutes to supply 100 gallons of filtered water.

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LATRINES.

The shallow trench system was used throughout the camps, and was most satisfactory.

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Size.—Where ground was limited, the trenches were dug 2 feet deep, otherwise 1 foot. Their length was 3 feet, breadth 1 foot, and the interspace was 2½ feet. This interspace was sufficient to allow another row of trenches to be dug in it if ground was limited.

Odour.—There was no smell about the trenches.

Flies.—There was a marked absence of flies about the trenches. Although the weather was against the presence of flies, in a few instances deep trenches were dug on the arrival of the regiments and closed after two days. These deep trenches smelt very offensive and many flies were present, the difference to the conditions about the shallow trenches being very marked.

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Number.—Trenches were generally dug for 5 per cent. of troops.

Time they Lasted.—They generally lasted two days, but in one regiment for four days; this was because the earth, for covering, was finely sifted, and the contents of trenches, which tend to get heaped in the centre, were levelled down.

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Orders were issued to the men to throw earth into the trench after using it, and the following means were adopted to enable them to do so:—

(1). Empty tins.
(2). Improvised scoops made of empty tins with wooden handles.
(3). Cheap grocers' scoops similar to (2).

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Supervision.—The following methods were adopted to supervise the carrying out of this order:—

(1). Policed by men who remained on duty until they found another man neglecting to obey the order.—This was very useful at first, but later on unnecessary.
(2). Policed by one of the sanitary police who was stationed at the latrine at fixed hours.—This method was most satisfactory and generally adopted.

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URINALS.

I tried making urinals by having shallow trenches leading into a pit filled with large stones.

The trench was for use and the pit to take the excess.

Size.—Trenches.—Depending on strength. For a regiment, two of 6 feet long were sufficient.

The gradient from commencement of trench to pit was 1 inch for each foot length.

Pit.—Depending on strength and soil. Three feet deep and 2 feet diameter was generally sufficient.

Time Lasted.—Trenches.—About two days. When foul, fill in and dig fresh ones.

Pit.—About 14 days.

The result was very satisfactory, and preferable to the usual open pit.

An inner screen should be put round the pit to prevent men from using it instead of the trench.

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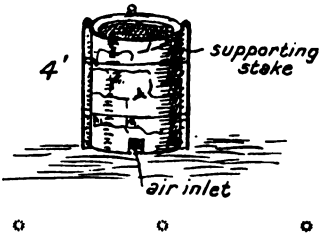
DISPOSAL OF REFUSE.

Camp.—The following methods were adopted:—

(*a*). High cylinder built of sods with air inlets at base.

This is a most efficient method, and is most suitable when the soil is turf; it burns away if it is peaty.



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(*c*). Pit with central cone of stones.

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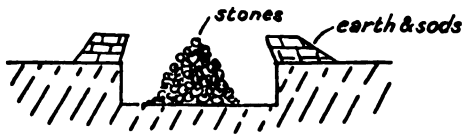
Very efficient and quickly built. Suitable when stones are available. I tried empty tins filled with earth, but it was not a success.



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The above crematoria were very satisfactory, and, in the case of pattern (*a*), when once the fire was lighted it kept going for three weeks, and only relighted twice. The residuary ash in the crematory, after three weeks, was very small. In (*c*) the destruction was not so complete, and the residue was buried in pits.

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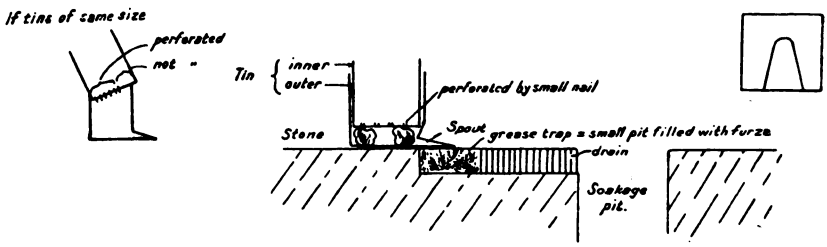
Kitchen (*Greasy*) *Water.*—All water was strained, and run into soakage pits.

The following methods were found to be good and easily improvised :—

(*a*). Two large biscuit tins, the upper one acting as a coarse strainer and, when required, emptied into a refuse tub, the lower directing the water over a small pit, which acted as a grease trap and was filled with furze (dried grass, heather, hay, etc., can be used), which was burnt and renewed daily.

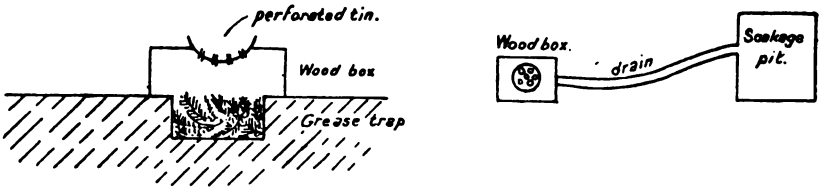
A narrow and shallow trench ran from this small pit into the large soakage pit.

The spout of the lower tin is easily made by making an inverted **V**-shaped incision, turning it down and rounding off.



(*b*). An adaption of (*a*).

A box turned upside down over the grease trap (pit), a hole cut in its bottom, and a perforated cullender or tin fitted into the hole.



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Ablution Benches.

I do not like the ordinary ablution bench, as, even when foot-gratings are used, the ground around always becomes wet and muddy.

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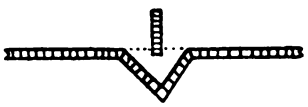
The —V— bench has many advantages (cleanliness, self-draining, etc.), but there are two disadvantages, viz. :—

(1). When emptying a basin, the water is very apt to go over the other side and wet the man opposite.

I suggest an upright plank over the V, thus :—



(2). The square box at the bottom of the overflow requires to be wider, as water splashes over and fouls the ground.

If these defects can be remedied, I think this bench would be much better than the ordinary grating bench.

Clothes Drying.

Was generally done on the heather, gorse, or trees about the camp.

Some regiments had posts and ropes in regular drying grounds; this was an improvement.

One regiment had a marquee for drying clothes. It was fitted with posts and ropes, and had charcoal braziers on the ground. Tins or buckets, with holes, do for braziers. In this marquee the wet clothing of two companies was dried in two hours.

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NOTICES OF MAGAZINES.

Journal des Sciences Militaires.

January 15th, 1908.

Lieut.-Colonel A. Grouard continues his criticisms on the "Strategy of the Franco-German War."

This paper deals with the actual and the possible dispositions of the French Army, after the defeat of General Frossard and the 2nd Corps d'Armée at Forbach, on August 6th, 1870. He blames Marshal Bazaine for not having proceeded to the field of battle, assumed command, and reinforced the 2nd Corps by the 3rd, which would probably have enabled the French to drive back the Germans beyond the Saure river, and to keep them there till the 10th or 11th. This success, although of a very temporary nature, would have materially assisted the organization of the troops in the rear.

A retirement of the whole French Army before that of the Germans, superior in numbers, organization, and elated at their success, was, however, inevitable, but Lieut.-Colonel Grouard considers that the retreat should have been in a southerly direction, the French right resting on the Vosges mountains; and that, preparatory to this retirement, the bulk of the French Army should have taken up a position between Morhange and Fenestrange, facing north.

In a future paper he proposes to show that the French could have held that position for some days, thus enabling the corps, defeated at Woerth and Forbach, to be reorganized.

Lieut.-Colonel Camon deals with "The Napoleonic Battle: Its Technical Preparation." This is a final article of a series. Examples are given showing how Napoleon, on discovering the dispositions of his opponents, at once assumed the initiative, by framing a well-considered scheme for the probable battle, on which preliminary orders were based; how this general idea developed into a more definite sketch of the battle on receipt of fuller information, and how the final orders for the battle were not issued until he had, with infinite trouble, not only verified the accuracy of the information itself and of the deductions he had made from it, but had also closely reconnoitred the enemy's position.

In his article, "Le Nombre des Corps d'Armée," Commandant Manceau favours the reduction of the number of army corps to 15, on the ground that the remaining corps could be maintained on a war footing, and would thus be composed of better trained men, who could be more quickly mobilized and better commanded—15 capable generals being more easily provided than 20. He contends that, with an army so organized, the needs for small wars could be more easily met than under existing conditions, and that, on a serious emergency arising, a fully

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prepared army could be concentrated on the frontier without awaiting the reservists, who could be organized at greater leisure.

This would provide France with an army somewhat similar to that of 1870. It would differ, however, in having behind it a large number of trained reservists, with the necessary organization for their mobilization.

In an interesting account of Masséna's attack on the Austrians at Ebersberg, on May 3rd, 1809, Capt. Briat speculates on the reasons which led him to attack, with the advanced guard of his corps, 40,000 men entrenched in a formidable position, after having been warned by Napoleon not to do so. In spite of the heroic behaviour of the French troops engaged in what Napoleon called a foolhardy enterprise, three French brigades lost 3,000 men, and were in the greatest jeopardy, when the approach of the Emperor with his main army forced the Austrians to retire. Capt. Briat rightly contends that Masséna's inordinate ambition, and desire to make amends for want of energy in a previous engagement at Landshutt, led him to commit this fault.

Lieut.-Colonel Souviat puts forward proposals for obtaining 10,000 men for the native armies, by applying to the Algerian tribes the French Conscription laws of 1832.

An anonymous article on "Quick-Firing Field Artillery" is completed. After a detailed examination of the steps taken by all military nations to provide such artillery, the conclusions arrived at are—that all countries either are, or will shortly be, provided with guns of the type first adopted by the French; that shields for the gun detachments are essential and do not ordinarily increase the visibility of the batteries; that limber boxes should be armoured, and that an observatory and telephone are needed for the officer commanding the battery. He also considers that a certain proportion of shells, with percussion fuzes, should be supplied to field artillery in addition to shrapnel, but that, in addition to quick-firing guns, quick-firing howitzers are needed in the field to destroy entrenchments.

It is pointed out that quick-firing ordnance, the carriages of which remain stationary under fire (the recoil being taken up in the carriage), can find firing positions with greater facility. The only drawbacks to the system are the possible waste of ammunition (this ammunition should be under the control of the officer commanding, and need not be considered). Another difficulty is that of replenishing the supply of ammunition. This has not been satisfactorily dealt with yet, and probably the use of motor cars will solve the question. The English field gun is said to be unnecessarily heavy, and the article shows that most nations have adopted guns similar, in calibre and weight, to the French gun of 75 mm.

Capt. Besset, after considering the great help a cavalry division would receive from a body of mounted infantry being permanently attached to it, suggests the formation of an experimental company, consisting of 7 officers (including medical and veterinary officers) and 230 rank and file, mounted on mules. In addition, there would be one machine gun, and each man would carry on his person or on his mule 256 rounds of ammunition.

'G.'

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REVISTA DE ENGENHERIA MILITAR.

December, 1907.

DEFENCE OF THE PORT OF LISBON BY MEANS OF FIXED SUBMARINE MINES.—By Lieut. M. Silveira e Castro.—This article gives an account of what was apparently the first submarine-mining practice ever carried out at the mouth of the Tagus. It commenced on the 1st July, 1907, and was brought to a conclusion on the 4th September, when 28 E.C. mines, with their cables and junction boxes, were laid out in the presence of the late king. Many difficulties were naturally met with during the practice, the greatest being a deficiency in *personnel*, which was remedied on the 25th August by the transfer of 1 subaltern and 40 men from the Engineer Regiment to the torpedo company. Other difficulties were experienced from the strength of the tides, the width of the river, and the consequent difficulty of getting suitable alignments, and the unevenness of the bottom; but all were successfully overcome, and the detailed account of the final inspection is sufficient to gladden the heart of an old submarine miner, and to make him regret that our own splendid system of submarine mines has been swept away and put on the scrap heap.

On the inspection day work commenced at 6.30 a.m. The 28 mine cases were got out of the mine store, loaded with dummy guncotton, primed, and taken down to the pier. The positions of the mines and junction boxes were buoyed, the J.B.'s and main cables laid out, and by 11.30 a.m. 16 E.C. mines had been laid. A launch carrying spectators then fouled one of the branch cables, and there occurred one of those aggravating delays so well known to the submarine miner. It was not till 2.30 p.m. that work could be resumed, and all the 28 mines were not in position until 5 p.m., instead of at 3 p.m., as had been intended. The mines were very well laid, and with one exception showed on the surface simultaneously. The number of men engaged was 16 sergeants and 129 men, under the command of Major Gomes Teixeira, who is to be congratulated on the results obtained.

THE HAGUE CONFERENCES.—By Capt. João d'Oliveira.—This article, which is continued in subsequent numbers, gives a good general summary of the events that led up to the first Hague Conference of 1899, of the results of that conference, and of the chief matters which have been brought to arbitration since that date.

SOME EXTRACTS FROM THE REPORT OF THE ENGINEER REGO LIMA ON HIS EXPEDITION TO THE MINES OF CASSINGA IN 1898 (*continued*).—In this number the description of the geological features of the Bundambungo district is completed, and that of the Mocambangua district is commenced. A map is given showing the outcrops of quartz in Mocambangua.

NOTE ON THE CALCULATION OF THE CHARGES OF MINES.—In August, 1907, the Swiss *Revue d'Artillerie* published an article on this subject, and the results arrived at were tested at the Portuguese Engineer School of

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Instruction at Tancos. They included a new formula, due to Professor H. Höfer—

$$C = gh^2 \sqrt{(1+n^2)^3},$$

where C = the charge in kilogrammes, h = the length of the line of least resistance in mètres, and $n = \frac{r}{h}$ also in mètres (r = the radius), and g is a coefficient, constant for the same kind of soil and same nature of explosive.

Other formulæ often employed are:—

$C = gh^3 \sqrt{(1+n^2)^3}$ (Belidor).

$C = gh^3 \left(\frac{4+3n}{7}\right)^3$ (undercharged mines)
$C = gh^3 (0{\cdot}09 + 0{\cdot}91n)^3$ (overcharged mines) } (Lebrun).

$C = gh^3 \sqrt{(1+n^2)^3} - 0{\cdot}41^3$ (French School of Mines).

It will be noted that Höfer's formula differs from the others, in that it makes the charge proportional to the square, instead of to the cube, of the line of least resistance. The value of g in the case of each of these formulæ (ordinary soil and black powder) was found to be as follows:—

Belidor = 1·00. Lebrun = 1·41. School of Mines = 1·6. Höfer = 3·28.

Where the line of least resistance = 1 mètre, and $n = 1$, the four formulæ give the following surprisingly different results:—

C = 2·83 k.g. (Belidor).
C = 1·41 k.g. (Lebrun).
C = 1·6 k.g. (School of Mines).
C = 9·28 k.g. (Höfer).

Each of the above charges was actually tested, and it was found that the charge as given by Höfer's formula was the only one which produced the expected results.

DESTRUCTION OF JAPANESE SUBMARINE MINES AT PORT ARTHUR.—A translation from the *R.E. Journal* of an article which appeared in the *Voĕnnyi Sbórnik*.

THE MILITARY MANŒUVRES IN SPAIN.—A brief description of the manœuvres which took place in Galicia last September, with a translation of the *précis* of the work carried out in them by the engineers, which appeared in the November number of the *Memorial de Ingenieros*.

REVIEW OF BOOKS.—*Notes on the Tactics and Strategy of Combined Operations between Land and Sea Forces* (*Apontamentos sobre tactica e estrategia nas operações combinadas entre forças de terra e mar*), by José Cardoso, 1st Lieutenant of the Navy. Coimbra, 1907.—The book is well reviewed, and, as the subject is one of the very greatest importance to ourselves, it will no doubt be read with interest by those of our officers who are acquainted with Portuguese.

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January, 1908.

THE MILITARY BRIDGE TRAIN.—By F.C.—This is a *précis* of an article by General of Division Ribeiro d'Almeida, which was sent to the *Revista*, but proved too long for insertion *in extenso*. After some historical remarks on the employment and composition of bridge trains from the time of the Romans down to the Peninsular War, the author proceeds to consider the existing bridging equipment of the Portuguese Army, which he characterizes as insufficient, and he recommends that some officers should be sent to study the subject abroad.

DIRIGIBLE BALLOONS OF THE PRESENT DAY AND FIELD BALLOON PARKS.—By Lieut. Pedro Ribeiro d'Almeida.—This is an interesting article, and gives a good summary of the principal dirigible balloons which have been produced in recent years. The following data are extracted:—

The "Patrie."—Capacity, 3,150 cubic mètres; major axis, 60 mètres; greatest diameter, 10·50 mètres; shape, a solid of revolution, the maximum section occurring at a point $\frac{2}{5}$ths of the length of the major axis from the bow; permanency of form attained by an air compensator; stability obtained by a series of horizontal and vertical planes, some fixed, others movable; motive power derived from a Panhard 70-h.p. motor driving two propellers, one at each end of the car.

The "Ville de Paris."—Capacity, 3,195 cubic mètres; shape, fusiform; major axis, 62 mètres; greatest diameter, 10·50 mètres; permanency of form attained by an air compensator; stability is obtained by means of eight cylindrical balloons, disposed in pairs in the form of a cross round the rear portion of the main envelope; a 70-h.p. Argus motor drives a screw 6 mètres in diameter at the rear end of the car.

The "Zeppelin."—Capacity, 11,430 cubic mètres; shape, cylindrical, with ogival ends; length, 128 mètres; diameter, 11·70 mètres; permanency of form obtained by means of a series of aluminium rings, with spokes like those of a bicycle wheel, which divide the machine into 17 compartments, each of which contains a balloon filled with hydrogen; each compartment communicates with the next, and the whole is covered by an envelope of varnished silk; its stability is obtained by means of a series of planes; an 80-h.p. Daimler motor drives three pairs of screws placed between the car and the balloon.

The "Parseval."—Capacity, 2,800 cubic mètres; shape, cylindrical, with a hemispherical bow and ogival stern; length, 52 mètres; diameter, 8·90 mètres; permanency of form attained by two air compensators, placed one at each end of the cylinder, and capable of inclining the balloon either upwards or downwards; stability is obtained by two horizontal and one vertical plane, and by the power of altering the position of the car; a 90-h.p. Mercedes motor drives a screw placed between the car and the balloon; the screw is of cloth, and only takes a rigid form when in motion under the action of centrifugal force.

The "Gross."—Capacity, 1,800 cubic mètres; shape, cylindrical, with hemispherical ends; length, 40 mètres; diameter, 12 mètres; permanency of form is attained by an air compensator; stability is obtained by one vertical plane above the balloon and two horizontal planes placed on a

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level with the platform, which, in the "Gross," as in the "Patrie," is placed between the balloon and the car; a motor of from 30 to 35 h.p. drives two screws placed one at each end of the envelope, and as close to it as possible. This machine, like the experimental one of the Comte de La Vaulx, can be readily packed for transport in carts.

This article is to be continued.

THE HAGUE CONFERENCES (*continued from the December number.*)—The proceedings of the 1907 Conference are considered.

THE NEW REGULATIONS FOR THE MILITARY TELEGRAPH SERVICE.—The military telegraph service is under an inspector, with the rank of colonel, a sub-inspector (either a lieutenant-colonel or major), who is responsible for all financial details, and a captain and adjutant, who is in charge of the offices and of the electro-technical institute. There is one fortress telegraph company, commanded by a major, who is Director of the Lisbon Telegraph School, with four subalterns. Of these latter, one is quartered at Oporto, and is in charge of the Telegraph School in that city, where the men of the 3rd and 6th Divisions are trained, and he also commands the section in the districts garrisoned by these divisions. The three remaining subalterns are attached to the Lisbon school, and respectively command the sections in the 1st, 2nd and 5th, and 4th Divisions.

The telegraph company has now been given charge of the fixed military wireless stations, and of the balloon park.

CHRONICLE.—In Germany it is proposed to construct a network of military roads, suitable for motor traffic, along the western frontier, and connecting it with the Rhine and the Maine.

In France a large increase has been made to the number of the telegraph companies, which are now organized into a regiment of two battalions, each of four companies.

'M.'

RIVISTA DI ARTIGLIERIA E GENIO.

November, 1907.

ENGINEER TROOPS DURING THE RUSSIAN-JAPANESE WAR.—Monteleone (Capitano del Genio).—

RUSSIA.

Sappers.—At the commencement of the war the 1st and 2nd Battalions of Eastern Siberian Sappers, attached to 1st and 2nd Army Corps, as well as the sapper companies of Kuantung, were stationed in the Viceroyalty of the Far East. The mobilization of these troops took place on the 10th February, 1904. A third battalion of sappers formed part of the 3rd Army Corps. In March, 1904, the 4th Battalion of Sappers of Eastern Siberia was formed.

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After the crossing of the Yalu by the Japanese in May, 1904, the technical troops were constituted as follows:—The 1st, 2nd, and 3rd Sapper Battalions had each four companies of sappers, one pontoon company, and one telegraph company, whilst the 4th Battalion, which served as a nucleus for the sapper companies of Western Siberia, consisted of two companies of sappers and one of telegraphists.

The sapper companies, after the Battle of Nanshan, were despatched to take part in the siege of Port Arthur.

The technical troops increased gradually with the formation of new Siberian army corps, and on the arrival of the European army corps the 5th and 6th Sapper Battalions were formed, each consisting of two companies of sappers and one of telegraphists, and each European army corps had a sapper battalion with three sapper companies, and one company of telegraphists.

It was soon found that one sapper battalion for each army corps was not sufficient, and in February, 1905, five new sapper battalions were sent out to the theatre of war.

Pontoon Companies.—The Pontoon Battalion of Eastern Siberia, consisting of three companies, was brought up to full strength in May, 1904. The three pontoon companies of the 1st, 2nd, and 3rd Sapper Battalions of Eastern Siberia were detached in November, 1904, from their respective battalions, and were formed into two new pontoon battalions. The 2nd Pontoon Battalion of Eastern Siberia was formed of the companies of the 1st and 2nd Sapper Battalions, the 3rd Pontoon Battalion, and one company of the 5th Pontoon Battalion stationed at Kiew.

In the spring of 1905 the 1st European Pontoon Battalion was also sent to the theatre of war.

Aerostats.—At the commencement of the war the Russians had at the theatre of war only one company of Siberian aerostats. The 1st Aerostat Battalion of the new Eastern Siberian formation was sent from Europe in October, 1904. The Siberian aerostat companies were transformed, in November, 1904, into the 2nd Eastern Siberian Aerostat Battalion. In July, 1905, a third Eastern Siberian aerostat battalion was formed from aerostat detachments of the fortified region of Varsovia.

Telegraphists.—Each sapper battalion had one company of telegraphists. During the war detachments of telegraphists were formed, who were directly posted to theGeneral Staff.

On the 23rd June, 1904, the 1st Eastern Siberian Telegraph Battalion was formed, and the 2nd Battalion on the 21st December. Each battalion had four companies.

At the same time as the formation of the 2nd Eastern Siberian Telegraph Battalion, the 1st and 2nd Telegraph Companies were created exclusively for radio-telegraph service, and in the spring of 1905 a third telegraph company was formed for the same service. Later on these three companies had another name; the first two were called the 1st and 2nd Eastern Siberian Radio-Telegraph Companies. These last did not arrive at the theatre of war before the conclusion of peace, and were assigned to the 1st Sapper Brigade.

Railways.—Whilst at the commencement of the war there were only

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20 railway companies in Eastern Asia, the number had increased to 32 at the end of 1904.

These companies, together with two battalions of four companies, formed the railway brigade of Ussuri, and four battalions of six companies formed the Railway Brigade of Transamun.

At the commencement of 1905 the 3rd European Railway Battalion was sent to the theatre of war.

The Commander-in-Chief of the mobilized army had also ordered the formation of a railway battalion for field exercise. The number of companies of this battalion is not known.

Engineer Field Parks.—Each of the nine army corps at the theatre of war was provided with a section of the Engineer Field Park. The 5th Engineer Field Park furnished one section, and the 2nd, 3rd, 4th, and 6th Field Parks supplied two sections each.

Mining Companies.—The mining companies of Eastern Siberia, which belonged normally to the fortress troops, were attached to the Army of Manchuria.

Thus the following technical detachments were employed:—

(*a*). *European Field Formations.*

One sapper battalion and one section of engineer field park for each of the Ist, IVth, Xth, XVIth, XVIIth, XIXth, Vth Siberian, and VIth Siberian Army Corps, and at the disposition of the supreme command of the army.

The Sapper Battalion of Grenadiers.

The 5th, 8th, 9th, and 13th Sapper Battalions.

The 1st Pontoon Battalion.

The 3rd Railway Battalion.

The 3rd Railway (complementary) Battalion.

Half squadron of telegraphists and one sotnia of telegraphists; the two last of new formation.

(*b*). *Asiatic Field Formations.*

One Eastern Siberian sapper battalion to each of the Ist, IInd, IIIrd, and IVth Siberian Army Corps.

The sapper companies of Fruantang at Port Arthur, at the disposition of the supreme command of the army.

The Eastern Siberian 1st, 2nd, and 3rd Pontoon Battalions.

The Eastern Siberian 1st and 2nd Telegraph Battalions.

The Eastern Siberian 1st and 2nd Radio-Telegraph Companies.

The Eastern Siberian 1st, 2nd, and 3rd Aerostat Battalions.

The Ussuri Railway Brigade of two battalions.

The Transamun Railway Brigade of four battalions.

The Railway Battalion for Field Exercise.

JAPAN.

Japan had not only its own technical troops formed on mobilization, but also created new detachments during the war.

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Before the commencement of hostilities the technical troops of the permanent army consisted of 13 pioneer battalions, one railway battalion, and one battalion of instruction for telegraphists with two companies, with one section of instruction for aerostats.

The pioneer and railway battalions had three companies each. Besides these there were three companies of pioneers in the island of Formosa.

Pioneers.—The distribution of battalions of permanent pioneers at the Battle of Mukden was as follows :—

1st Army—2nd and 12th Battalions of Pioneers of the Guard.
2nd Army—4th, 5th, and 8th Pioneer Battalions.
3rd Army—1st, 7th, and 9th Pioneer Battalions.
4th Army—6th and 10th Pioneer Battalions.
5th Army—11th Pioneer Battalion.
General Reserve—3rd Pioneer Battalion.

The Reserve Division of the 5th Army had one pioneer battalion (complementary) with three companies.

The other 12 companies of pioneers (complementary) were distributed among the several armies.

There were then 13 pioneer battalions of three companies, or 39 companies, 15 companies of pioneers (complementary); total, 54 companies.

At the end of the war the Japanese Army consisted of 17 permanent divisions, and two in reserve.

The pioneers were increased by four battalions of three companies, and five companies (complementary), or by 17 companies. So that at the end of the war there were 71 pioneer companies.

Telegraphists.—The pioneer battalions on mobilization furnished the General Staff with detachments of telegraphists, and each permanent division had one section of field telegraphs.

Owing to the formation of new divisions, the telegraph troops were increased, so that at the end of the war there were 17 field telegraph sections.

Railways.—There were at the theatre of operations—

One railway battalion of three companies.
Two special sections of field railways.
The railway administration for the Manchurian Army.

Comparing the effective technical troops of the belligerents, there were :—

Russia.	*Japan.*
55 sapper companies.	71 pioneer companies.
8 pontoon companies.	22 telegraph sections.
28½ telegraph companies.	5 railway companies or sections.
6 aerostat companies.	
50 railway companies.	
9 sections of engineer field park.	

It appears that all the Russian sappers and Japanese pioneers had received instruction in mining.

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TELEGRAPH SERVICE.

Electric Telegraphs and Telephones.

Russia.—The first detachment of telegraphists appointed to the supreme command was formed at the end of 1904, and was called the 1st Telegraph Battalion of Eastern Siberia; the 2nd Battalion was only formed at the end of the same year. Both battalions had the defect of an improvised formation, more especially as the *personnel* had but little practice with the material at its disposal. The telegraph companies belonging to the sapper battalions responded indifferently to the exigencies of the service. In the telegraph companies of the 2nd Sapper Battalion there were only 50 men who knew how to read and write properly.

On the battlefields only the larger tactical units were connected by telegraphs or telephones. The ordinary communication between the smaller detachments of troops was either by signal horns or drums, or by flags and lanterns.

The experience acquired during the course of the war showed that during a battle the transmission of orders by telephone was limited to small distances, and the correspondence by visual signalling was not sufficiently rapid or secure.

Japan.—Contrary to what has been said in the case of Russia, the Japanese, at the commencement of the war, had made large use of the telegraph and telephone. By means of a proper organization, the divisions in peace times were conveniently provided with these important means of communication.

On the march the field telegraph sections, attached to each division, supplied, at first, telegraphic communication between the Q.G. of the division and the commander of the army, and then, if time permitted, extended a telephonic line alongside the telegraph. The Q.G. of the divisions also communicated telephonically with the brigade commanders and with the commanders of artillery. The rapid working of these means of communication was due, in a great measure, to the light material with which the divisions were provided. In spite of the intense cold during and after the Battle of Mukden, and the frozen condition of the ground, the extension proceeded at an average rate of one kilomètre per hour.

The infantry battalions were partly provided with portable telephonic apparatus and about five kilomètres of wire served by one non-commissioned officer and four men from the troops. The uncovered wire was generally held in more favour than covered wire, which was frequently broken by the troops or carts passing above. When the bamboo poles carried by the troops fell short, posts from woods or any material in the neighbourhood were substituted.

The field telegraph sections of the Divisions of the Guard constructed 960 kilomètres of lines, and repaired 200 kilomètres; those of the 2nd Division put up 1,034 kilomètres, and repaired 250 kilomètres; and those of the 12th Division put up 920 kilomètres, and replaced 300.

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Radio-Telegraphs.

Russia.—Each company of radio-telegraphists was divided into two sections, each of which had three radio-telegraph stations of the Marconi system.

The strength of the companies in peace times was 12 officers, 208 men of the troops (of whom 187 were combatants), 22 horses, 194 carts; in war there were 12 officers, 426 men of the troops (of whom 187 were combatants), 270 horses, and 194 carts.

The train was composed, at the theatre of war, of two-wheeled carts. The technical train of a company contained 128 carts; that of a section, 62; that of a station, 14. The carts were divided into station carriages, antennæ, accumulators, receivers, machine, earth. The antennæ were of bamboo, composed of various parts, having their extremities wrapped round with metallic wire.

The 1st and 2nd Radio-Telegraph Companies of Eastern Siberia only, were employed at the theatre of war.

The first of these companies was charged with the communication of the 2nd Army with General Misctcenko's cavalry brigade on the extreme right wing. There were, besides, other stations, but, notwithstanding the short distance, the telegraph worked very badly. The superior commanders soon gave up using the radio-telegraph, and in the army this system of telegraphy, formerly *wireless*, came to be called *useless*.

The principal reason of the initial failure of the wireless telegraphy was, that the troops sent to the theatre of war had received no instruction. Besides this, the weather disturbances were very frequent at these stations. The instruments, although carried on two-wheeled carts, were too heavy to allow of their following the cavalry detachments.

However, owing to continued practice in the instruction of the *personnel* towards the end of July, the high military authorities recommenced to use this means of communication.

Wireless Telegraphy.

Russia.—During a reconnaissance made by the Japanese of the Corps of General Grekov, General Misctcenko made use of wireless telegraphy because the ordinary telegraphic service was interrupted. He obtained replies in 20 minutes, and from that time the value of wireless telegraphy was recognized. Telegrams were received with writing apparatus from a distance of 70 k.m. Rapidity of correspondence increased, and became finally over four times what it was when first started.

As the Russians and Japanese made use of the same system of wireless telegraphy, disturbances originated in the Russian correspondence owing to the working of the Japanese instruments. It was then proposed to institute two lines of stations, one to protect its own and to disturb the Japanese correspondence, and the other for the transmission of messages. However, this plan was never carried out.

Japan.—As the Japanese Army in the field was not provided with the apparatus for wireless telegraphy, the disturbances in the Russian correspondence were probably caused by the wireless telegraph stations in Corea.

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Visual Signalling.

Russia.—After experimenting for several years for a suitable means of communicating by visual signalling, it was concluded to use signalling flags similar to those adopted by other States.

But at the commencement of the war the Russian Army had not this means of correspondence.

The good results obtained by the Japanese, from the employment on a large scale of flags and lanterns, influenced the Russian Commander-in-Chief to make arrangements for a system of visual signalling, and this was introduced in a modest form in the Manchurian Army. An order was issued that each company, squadron, sotnia, or battery should have at least four men well instructed in this mode of correspondence. The officers of certain regiments were also required to understand visual signalling.

Red flags were exclusively used, and the signalling corresponded exactly to the German system. During the summer of 1905 lanterns of acetylene gas were partly used.

The heliograph was employed, by the telegraph companies of battalions, as a complement to the telegraph wire and telephone. Near Tachiciao, four stations were opened at a distance of 4 k.m. from one another.

At Liaoiang and Mukden there was a considerable extension of this means of communication.

In the positions on the Sciaho the heliograph stations were at a distance of 7,500 miles, and the instruments appear to have worked satisfactorily.

The Russians seem to have made frequent use of beacons on the heights near the occupied positions, but apparently they were not very successful.

Japan.—For about six months before the declaration of war, the Japanese had instructed many Chinese, from the districts of Corea and Manchuria, in signalling. By day and in sunshine heliographs were used, flags when the sky was obscured, and lanterns at night. The signallers were well paid by the Japanese.

During the frequent night combats at the end of 1904, in addition to the lanterns, the Japanese made use of small balloons inflated by hot air. The balloons had lamps of various colours which had conventional signals.

Balloon Service.

Russia.—The balloon companies of Siberia, at the beginning of 1904, went to Liaoiang from Europe.

At the end of July, the companies marched with the Xth Army Corps to Kuadsiatsi, 40 k.m. south-east of Liaoiang.

Notwithstanding the wretched state of the roads, the transporting of the material, with which the company was equipped, was effected in 76 carts. The gas was prepared with iron and sulphuric acid, and shortly after arriving at Kuadsiatsi it was possible to commence observations. The distance of the balloon from the enemy did not exceed 5 k.m. From the balloon, observers were able to see the Japanese detachments, their earthworks, their batteries, and even single men.

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On the 23rd August a balloon-observing station was established near Liaoiang, between forts Nos. 2 and 3.

On the 31st August, the balloon was of great use to the Russians, as it was able to discover in time the threatened surprise on the Russian right.

On the same day the balloon was exposed to the enemy's artillery fire. The distance must have been known to the Japanese, as the first shell burst very close to the car.

Ten shots were fired without any damage to the balloon.

On the following days, fire was opened on the balloon, by the siege artillery, but without result.

In October, the Siberian Balloon Company took part in the general advance of the Russians, and marched with the advance guard of the Xth Army Corps on Sciahopu, where it made many observations. The observations were communicated from the balloon, by means of the heliograph.

By a decree of the 3rd November, 1904, the Siberian Balloon Companies were transformed into a battalion, which assumed the name of the 2nd Balloon Battalion of Eastern Siberia. Previously there had only been the 1st Battalion. Both battalions had a light equipment adapted for field service. With the production of gas by means of the hydrate caustic of soda and aluminium a considerable reduction of weight was obtained, so that the first stage for an ascent consisted of 26 carts.

The battalion proceeded to Mukden in December, 1904, and occupied some huts constructed near the station.

In this locality they continued to instruct the troops in the management of balloons and of signalling apparatus. At the end of February, the two companies continued their observations and reconnaissances of the Japanese positions in front of the 2nd and 3rd Armies. They observed that the Japanese continually increased the number of their trenches, and reinforced their positions. Photographs were made from the balloon of the village of Sandepu, and the entire region round about was found to differ with the maps.

The work was very difficult owing to the intense cold. The Japanese fired at the balloon from their advanced positions, and sometimes produced columns of smoke to conceal their positions.

The balloons were not only used for reconnoitring purposes, but also to conduct the fire of the artillery.

The balloons of the 1st Battalion were cannonaded nine times. Once a balloon was struck by three shrapnel bullets; two passed through; one remained in the covering and was discovered three days after when the balloon was being inflated. At great heights the balloon was quite secure from shrapnel.

Japan.—The Japanese do not seem to have used balloons in field warfare.

In conclusion it may be said that the telegraph and balloon service was incomplete in both armies. The Japanese, while they had provided sufficiently for the telegraph and telephone services, and for visual signalling, were wanting in a service of wireless telegraphy and of

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balloons; and the Russians, while having the advantage of these last, were not sufficiently prepared in the various branches of these two important services, and were not able to obtain good results.

It is now evident from the experience of this war that, with improvised formations, only scarce and insufficient results can be obtained.

EDWARD T. THACKERAY

THE ELECTRICIAN.

February 14th, 1908.

DRAWING OFFICE ILLUMINATION.—This is a description of the new drawing offices lately erected by Messrs. Armstrong, Whitworth & Co., Ltd., at their Elswick shipbuilding yard. In these offices the draughtsmen are continually at work for several hours without a break, and often on plans measuring 15 feet or more in length; hence the most even illumination, over every part of the drawing tables, is necessary. The lighting arrangements employed are the result not only of considerable experience in the older drawing office, but also of careful tests made with a view to determining the most suitable form of artificial lighting, and of diffusing and reflecting surfaces.

The drawing, designing, and tracing offices occupy two floors, the upper storey being lighted in the daytime by side windows and north lights in the roof, the lower one by side windows.

In order to diffuse the light as much as possible, the sloping roofs of the upper department are enamelled white, while downstairs the ceilings are whitewashed. Below these, at a distance of 10 feet from the floor, are suspended inverted arc lamps combined with conical reflectors, so arranged, that no light escapes from the crater of the arc at an angle from the horizontal of more than 5 degrees. Practically the whole of the useful light is thus flung upwards. In the case of the downstairs room this light is reflected downwards in a uniform manner by the ceiling itself, and a very close approximation to diffused daylight is thus obtained. In the upper department, however, the reflection obtained from the sloping ceilings was found to be totally inadequate. Several experiments were therefore made, and very good results have now been obtained by placing over the lamps a white enamelled reflector, 6 feet in diameter, 3 feet of which takes the form of a shallow inverted saucer, the remainder of the surface being flat and horizontal.

The lamps installed are of the Union Electric direct arc pattern (inverted light) of 10 ampères, at 43 volts. Five lamps are run in series on a 240-volt circuit, with a consumption of 10 ampères for the five lamps. One lamp is allowed for every 250 to 300 square feet, and they are placed at distances of about 18 feet from one another. In addition to the general lighting produced by these arc lamps, every fourth bench is provided with a special switch and flexible lead at the wall, running to a

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16-c.p. incandescent lamp, which can be used for close detail work. The chief draughtsman's office, the plan stores, cloak rooms, etc., are lit by means of incandescent lamps, while, in the printing room, two intense enclosed arc lamps operate at the centre of a large rotary printing machine.

February 21st, 1908.

ELECTRIC POWER IN DOCKS.—During recent years the use of electricity for power purposes in docks has been greatly extended, and it offers many advantages over the hydraulic system. This is especially the case when electric power can be obtained at a reasonable rate from an outside source, and the user has not to incur the heavy capital expenditure involved in the provision of a generating station. From the user's point of view, the advantages of buying power are great. The installation cost for distribution is small compared with that for a hydraulic supply, there is not the same liability to failure, and the consumption is proportionate to the work done. The efficiency of electrical machinery is also much higher than that of hydraulic plant for the same purpose, and the distribution is more flexible and lends itself better to alterations and additions.

The author proceeds to describe the many uses to which electrical machinery has been put in connection with dock working, such as coal conveyors, hoists, wharf cranes, capstans, etc., and also for driving hydraulic pumping machinery. Particulars of the machinery in use at several large docks are also given.

February 28th, 1908.

A DIRECTIVE SYSTEM OF WIRELESS TELEGRAPHY.—A closed oscillation circuit, placed in a vertical plane, radiates principally in the direction of its plane, and is, in that respect, suitable for a directive transmitter system, but the radiation therefrom is weaker than from an open circuit. An experimental directive system was recently established by Messrs Bellini and Tosi between three stations, Dieppe, Havre, and Barfleur, on the Normandy coast, with the object of examining, by actual experiment, the suitability of closed triangular radiating circuits for use in radiotelegraphy. From the Dieppe to the Havre stations the distance is 50 miles, and from Dieppe to Barfleur 100 miles, the angle between the directions being 23 degrees. At each station was a mast 50 mètres high, which supported, by its apex, an isosceles triangle of wire. With this form of oscillation circuit at the sending station, good results were obtained, so long as the plane of the sending aerial triangle was directed towards the recieving station, but on turning the triangle round the mast, the strength of the received signals gradually diminished to zero. Similar experiments were made with directive receiving, closed oscillation circuits being used at the receiving stations; and it was found that the best results were obtained, when the plane of the receiving aerial triangle was directed towards the transmitting station, but that the signals diminished to zero as the triangle was turned round at right angles to this. It was thus found possible, by regulating the emitted energy and suitably orienting the sending circuit, to send signals, at will, to either of the receiving stations, without the other station receiving signals. The

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authors then proceed to describe how the mechanical difficulties, involved in the orienting of the various triangles, may be overcome; this is done by adopting a method of directive telegraphy based on the above-mentioned principles, but having all its manipulation performed indoors.

AUTO-TRANSFORMERS AND METALLIC FILAMENT LAMPS.—Consumers who are on an alternating current system will be interested to learn that auto-transformers have been placed on the market, which will enable them to transform their supply to a sufficiently low voltage for metallic filament lamps. Although a transformer will be used ordinarily for the whole supply, if metallic filament lamps are fixed in only a few positions, a transformer can be fitted to each such lamp. These transformers are arranged for fitting direct to a ceiling rose or other point where low pressure is desired, and as they are less than 4 inches in diameter, and only weigh 6 lbs., there should be no difficulty in finding a convenient position for fixing. In this way the advantages of high-efficiency lamps of low candle-power can be obtained with the least possible alteration to wiring; and as these auto-transformers are controlled by the switches, there are no losses except when the lamps are in use.

DIRECT AND INDIRECT METHODS OF ELECTRICAL PURIFICATION OF WATER.—The author discusses various electrical methods of water purification, such as electrolysis and electric discharges to kill the bacteria, and comes to the conclusion that the best results are obtained from the indirect methods in which the electrical energy is used to produce an active disinfecting agent such as ozone, which is then applied to the water.

R. C. HAMMOND.

VOËNNYI SBÓRNIK.

December, 1907.

DEFECTS IN THE USE OF ENTRENCHMENTS.—The writer considers that the present system of instructing troops in the making of entrenchments is most unsatisfactory, and that little advance has been made in this matter since the war of 1878. The training, of sapper battalions, is carried out without any regard to the connection, which should exist between the work in the field of this branch of the service, and that of the infantry, and the latter are generally ignorant, and consequently neglectful, of the tremendous advantages to be gained by rapid entrenchments. A few remarks on this subject by Military Engineer Karaylschikoff, who had considerable experience during the late war, are quoted by the writer:—

"Every entrenching tool was left (by the infantry) on the former position.

"The private looks on his entrenching tool as an encumbrance, and throws it away on the first opportunity.

"The construction of No. 1 Redoubt has progressed very slowly. The

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troops displayed a complete want of interest in engineering works, and took no pains to preserve their entrenching tools.

"The constant misunderstandings between sappers and infantrymen, arising from the disinclination of the latter to work, have made me fearfully disgusted.

"Under the immediate superintendence of the regimental officers, a heap of useless—if not actually harmful—works are being carried out."

Other passages are quoted from this book to show how complete was the want of sympathy existing between the sappers and the other branches.

A serious fault, was the apparent inability of the infantry to entrench themselves without delay, on points occupied during the progress of a battle, and also their unwillingness to forsake the shelter of prepared positions, where they would wait until they were ousted. In other words, the value of hasty—as opposed to deliberate—entrenchments was not realized.

The remedy is to be found in constantly combining tactical training with practice in entrenchments. The writer considers that the annual training of sapper battalions should be divided into three periods. In the first, the sappers would be put through their usual annual course of fieldworks independently; in the second, they would, as a part of the corps to which they are allotted, go through combined training with the other arms. During this period the infantry, under their guidance, would be instructed in the intelligent use of locality with a view to defence, and also in such work as the passage of obstacles, preparation of hand grenades, bridging, mending roads, etc. During the third period, examinations would be held both for instructed and instructors.

ARMY ORGANIZATION.—The writer begins by stating the three guiding principles on which the organization of a force should be based:—

(1). A tactical unit must be of a size convenient for command.
(2). It must be capable of independent action.
(3). The internal union of a tactical unit must be complete.

Considering the first of these, he states that a corps should consist of two to three divisions, a division of two to three brigades, a battalion of four companies, etc. He estimates that the size of a company should be from 150 to 200 men. The reason of this is because, at the beginning of a fight, a company in the advance would have from two-thirds to three-fourths of its strength in the firing line, extended at two to three paces interval—a length of 300 to 400 paces—and this is as much as a company firing line ought to occupy in order to fulfil condition (1). Hence the strength of a company must be between 150 and 200 men.

To satisfy the second principle, a tactical unit must consist of a proper proportion of all arms, each arm being, in strength, a multiple of smaller subdivisions, so that smaller complete tactical units can be formed. An infantry regiment (three battalions) requires to complete it artillery, in the shape of machine-guns, cavalry and cyclists to act as orderlies, and engineers to look after telephones. A battalion would consist of four companies, subdivided into four sections and 24 squads of eight rifles each.

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Turning to larger units, under the present system a division consists of two infantry and one artillery brigade, and an infantry brigade contains two regiments. This is a most inconvenient arrangement when it is necessary to split up divisions into subordinate commands. A system, in which a brigade would consist of a due proportion of troops of all arms, would be far better; a suitable formation for a brigade would be:— Three regiments, two squadrons, a brigade of artillery (nine batteries of six guns each), and one sapper company of 108 men. A division again would consist of three complete brigades, two squadrons, a pontoon company, a telegraph section, and a balloon section. Similarly, an army corps, besides two divisions, would require an independent force of cavalry, reserve artillery of mountain guns and howitzers, engineer troops, and troops for the line of communications.

January, 1908.

This number contains an account of our new Territorial Army, and amongst other articles one on dirigible aerostats, but no mention is made in it of the "Nulli Secundus."

A supplement issued with the *Military Magazine* of January records the charges against Lieut.-Generals Stoessel, Smirnoff, and Fok, and Major-General Reuss, and a summary of the evidence on which the charges are based. Stoessel is accused under ten heads, briefly as follows:—

(1). Of not handing over the command of Port Arthur to General Smirnoff when he had been superseded by the latter.
(2). Of interfering with the duties of the Commandant of Port Arthur.
(3). Of failing to take the necessary steps to provision Port Arthur.
(4). Of receiving and reading, during the siege, certain remarks of General Fok, written in a manner derisive and cutting, calculated to undermine the authority of certain officers.
(5). With a view to his own aggrandizement, of falsely reporting himself as taking an active and energetic part in the Battle of Sinchau (Kinchau ?), whereas he did not leave Port Arthur.
(6). With a view to his own aggrandizement, and wishing to represent the conduct of his subordinates in a favourable light, of making false statements regarding the nature of the retreat of General Fok's detachment.
(7). With a view to his own aggrandizement, of reporting himself as taking part in imaginary battles.
(8). In order to justify his premeditated surrender of Port Arthur, of falsely reporting that the Japanese were masters of the North-West front, and that the ammunition was almost exhausted.
(9). Under false pretences, of recommending General Fok for the Order of St. George of the 3rd Class.
(10). Of surrendering Port Arthur in opposition to the opinion of a Council of War.

A. H. BELL.

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,, W. H. Moore, D.S.O., R.G.A.
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,, B. W. B. Bowdler, R.E.
,, F. D. Farquhar, D.S.O., Coldstream Guards.
*Capt. R. G. Parker, Rl. Lancaster Regt.
Capt. G. N. T. Smyth-Osbourne, Devonshire Regt.
Capt. V. H. M. de la Fontaine, East Surrey Regt.
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Capt. H. S. Williams, Dorsetshire Regt.
,, B. D. L. G. Anley, D.S.O., Essex Regt.
Capt. R. S. Hamilton-Grace, Durham Light Infantry.
*Capt. H. F. Baillie, Seaforth Highlanders.
,, P. S. Allen, Gordon Highlanders.
,, J. K. Cochrane, Leinster Regt.
,, R. L. Ricketts, Indian Army.
,, W. K. Bourne, Indian Army.
,, F. W. Lumsden, R.M.A.

The following Officers received nominations:—

Capt. H. C. Bickford, 6th Dragoon Guards.
Capt. C. J. C. Grant, Coldstream Guards.
Capt. W. D. Wright, V.C., Royal West Surrey Regt.
Capt. C. H. Harington, D.S.O., Liverpool Regt.
Capt. H. Wake, D.S.O., King's Royal Rifle Corps.
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Capt. G. P. Grant, D.S.O., Indian Army.

SANDHURST, JUNE, 1906.

FIRST	A. G. Armstrong 5,541	129th	R. P. T. Ffrench..... 3,827
48th	H. G. Gauntlet 4,515	181st	C. W. Molony..... 3,445
67th	D. Macdonald..... 4,299	186th	P. J. I. Synnott 3,386
89th	W. G. Bagot-Chester..... 4,115	190th	R. M. Aylmer..... 3,339
90th	A. G. Ottley 4,109	197th	O. Gough..... 3,262
93rd	A. P. Williams-Freeman 4,094	201st	P. W. J. A. Stomm 3,151
115th	D. M. Black 3,940	213th	B. W. Molony 2,881
125th	W. J. King-King 3,846		

WOOLWICH, JUNE, 1906.

31st ... ... J. S. Barkworth 6,483

DECEMBER, 1905.

SECOND	H. G. MacGeorge 7,196	16th	R. Crofton 6,330
FOURTH	G. Walton 7,046	45th	D. Stephenson 5,899
FIFTH	H. A. Cox 6,967	54th	J. Kennedy 5,711

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N. H. Hutcheson	2,105	D. C. Robinson	1,879
F. D. Frost*	1,949	F. A. Bowring	1,876

*Read partly at the Army College, Aldershot.

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THE ROYAL ENGINEERS JOURNAL.

Vol. VII. No. 6. JUNE, 1908.

CONTENTS.

		Page.
1.	**Coast Erosion and its Prevention.** By Col. W. Pitt, late R.E. (*With Plates*) ...	341
2.	**The Relation of Coast Defence to Home Defence as a Whole.** By Col. S. A. E. Hickson, D.S.O., R.E., *p.s.c.*	360
3.	**Some Notes on Aeroplanes.** By Capt. R. P. T. Hawksley, R.E.	367
4.	**The Fortification School at the S.M.E.** By Lt.-Col. B. R. Ward, R.E. ...	373
5.	**Memoirs:**—Lt.-Gen. James John McLeod Innes, V.C., C.B. By Col. Sir Edwd. T. Thackeray, V.C., K.C.B., late R.E.	384
	Col. Henry Francis Blair. By Col. Sir Colin C. Scott-Moncrieff, K.C.M.G., K.C.S.I., LL.D., late R.E.	387
	Major.-Gen. Charles Nassau Martin. By Lt.-Col. H. F. C. Lewin, late R.E.	389
	Capt. C. E. Vickers, R.E. By Major E. D. Swinton, D.S.O., R.E. ...	392
	The late Sir H. Tyler	394
6.	**Reviews:**—*Panorama Sketching.* By Capt. P. E. Lewis, R.F.A., and Capt. A. F. Green, R.G.A.	395
	Training and Tactics. By Capt. H. M. Johnstone, late R.E. ...	396
	Weapons. By B. E. Sergeaunt	396
7.	**Correspondence:**—John Hepburn, Engineer and Cleric. By Capt. M. Elrington-Bisset, late R.E.	397
8.	**Recent Publications of Military Interest**	399

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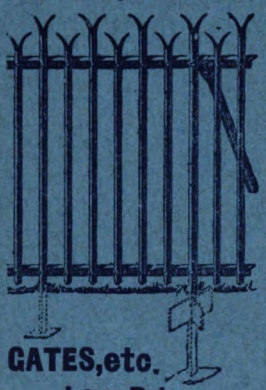

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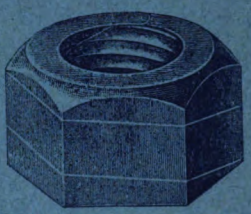

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CONTENTS.

PAGE.

1. COAST EROSION AND ITS PREVENTION. By Col. W. Pitt, late R.E. (*With Plates*) 341

2. THE RELATION OF COAST DEFENCE TO HOME DEFENCE AS A WHOLE. By Col. S. A. E. Hickson, D.S.O., R.E., *p.s.c.* 360

3. SOME NOTES ON AEROPLANES. By Capt. R. P. T. Hawksley, R.E. 367

4. THE FORTIFICATION SCHOOL AT THE S.M.E. By Lt.-Col. B. R. Ward, R.E. ... 373

5. MEMOIRS :—

Lt.-Gen. James John McLeod Innes, V.C., C.B. By Col. Sir Edwd. T. Thackeray, V.C., K.C.B., late R.E. 384

Col. Henry Francis Blair. By Col. Sir Colin C. Scott-Moncrieff, K.C.M.G., K.C.S.I., LL.D., late R.E. 387

Major-Gen. Charles Nassau Martin. By Lt -Col. H. F. C. Lewin, late R.E.... 389

Capt. C. E. Vickers, R.E. By Major E. D. Swinton, D.S.O., R.E. 392

The late Sir H. Tyler 394

6. REVIEWS :—

Panorama Sketching. By Capt. P. E. Lewis, R.F.A., and Capt. A. F. Green, R.G.A. 395

Training and Tactics. By Capt. H. M. Johnstone, late R.E. 396

Weapons. By B. E. Sergeaunt 396

7. CORRESPONDENCE :—

John Hepburn, Engineer and Cleric. By Capt. M. Elrington-Bisset, late R.E. 397

8. RECENT PUBLICATIONS OF MILITARY INTEREST 399

Authors alone are responsible for the statements made and the opinions expressed in their papers.

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COAST EROSION AND ITS PREVENTION.

By COLONEL W. PITT, LATE R.E.

THERE is no branch of civil engineering, however remote apparently from the ordinary duties of the Corps, that a Royal Engineer may not find himself suddenly obliged to undertake the study of. Frequently indeed he may find himself carrying out works before he has had time to gain even a rudimentary knowledge of the principles according to which they are, or should be, constructed.

Few people have any idea of the great extent of sea and river shore, for the protection of which the War Office is responsible, using the word "protection" in the sense of guarding that shore from the incursions of the sea or river, as the case may be, and not from invasion of another kind. Only those officers who may happen to have been stationed in the districts concerned, and the officials at the War Office, are aware that the Royal Engineers are responsible for warding off the attacks of the sea at certain places where these attacks are most persistent and dangerous, and where a failure to maintain the defence would result in the flooding of many thousands of acres of valuable land and enormous pecuniary damage.

The coast of England from the Wash to Portsmouth is generally considered to be that portion of our shores which is most exposed to attack by an invading enemy, and it is an unfortunate coincidence that it is also more subject here than elsewhere to the inroads of the sea, excepting, perhaps, part of the coast of Yorkshire. Really this is not a coincidence, because the conditions which favour the first kind of attack involve liability to the second also. The War Office has assumed most of its responsibility for foreshore protection and maintenance since 1805, when Napoleon filled the country with alarms by his elaborate preparations for invasion. As a protective measure many forts and over a hundred martello towers were constructed at intervals along the exposed extent of coast line. These were generally near, and sometimes close, to high-water mark as it then was. Of course, land for the defence works had to be acquired; each martello tower stood in an isolated plot varying from two to ten acres in area, and the forts required more land according to their size. Most of the martello towers were built between Eastbourne and Folkestone, with the object of preventing landings from boats on the open beaches; frequently the intervals between these towers are half a mile or less. Many were also erected on the coasts of Essex and Suffolk.

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Ever since these defence works were constructed a ceaseless warfare has raged round most of them between the Royal Engineer officer in charge and the tireless sea. On the whole victory so far has been mainly with the attack; of many of the towers no trace now remains. Others are below the present high-water mark, and their days are numbered. Of the forts some have disappeared; of two at least the gorges alone remain intact, and any storm may complete their destruction. The defence however has been but half-hearted, at any rate where there was only a question of the salvation of the works themselves. Long since regarded as obsolete, they have been dismantled, and many of the towers are now peacefully occupied either by fishermen or "week-enders." Amongst the latter they are strangely popular, and where not dangerously near high-water mark are let on lease for quite substantial rents. Others again have been sold. Under the circumstances described it would have been a waste of money to go to a great expense in constructing protective works for the towers, more especially as the War Office could not compel the owners of the intervening lengths of foreshore to do anything.

Apart however from the sites of the obsolete defence works, there are many places where it was imperative that the foreshore should be protected from the erosion of the sea, for example, from Dymchurch Redoubt eastwards to Hythe, and at Felixstowe. In the first-named locality there is constant encroachment, a source of great danger, because behind the beach lies Romney Marsh, many feet below high-water level, every acre of which would be drowned out were a serious breach to be made, as well as the rifle ranges of the School of Musketry at Hythe. At Felixstowe the butts in the rifle ranges near Landguard Fort have recently been imperilled, and if nothing were done, the fort itself would in time be cut off from the main land. There are many other danger spots which it is not necessary to specify here. It will suffice to say that they are not confined to the east and south coasts, much trouble having quite recently been caused in Milford Haven.

So far reference has only been made to protection from encroachments by the sea. There are however many miles of river embankments on the Thames, Medway, and other rivers forming the frontage to War Department property, often lying well below high-water mark. For the maintenance of these banks Royal Engineer officers are responsible. Failure might in some cases mean an almost national disaster. In 1707 the bank of the Thames at Dagenham, in Essex, was breached, and it was 14 years before the damage was finally repaired by Perry.*

Before dealing with the causes of erosion and the remedies it will perhaps be as well here to make some remarks as to the liabilities of

* *Lives of the Engineers, Vermuyden, Myddleton, Perry, James Brindley*, by Samuel Smiles, p. 138.

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landowners for the maintenance of the foreshore, as it is in this capacity that the War Office is affected. In a new country there would in all probability be a general law on the subject and a uniform practice. In our islands there is nothing of the sort; with every few miles we find varying conditions, and the local Royal Engineer officer has to make himself acquainted with them. As a general rule, and where it has not been alienated, the "foreshore," *i.e.*, the shore between high and low-water marks, is the property of the Crown. In many places it is vested in the lord of the manor, and often is in the hands of private owners or public bodies. This ownership however carries with it no responsibility for keeping high and low-water marks in the same place. They may, and in places do, change constantly. As the foreshore moves landwards through erosion or seawards through recession, so the ownership moves with it. Primarily the ground landlord is liable for the prevention of encroachment on his frontage to high-water mark. If the sea recedes, he gets the benefit. There are vast areas of accretion formed in this way, usually however covered with shingle, and of little, if any, value; examples may be seen at Dungeness and the "Crumbles," east of Eastbourne. Where the land behind the foreshore has at some time been reclaimed, and is protected by sea walls from being flooded, these walls, and the marsh land generally, are supervised by commissioners, often adorned with ancient and sonorous titles, whose duty it is to keep all safe. The cost of maintenance is recovered by a rate levied on the land interested, sometimes called a "scot"—hence the term "scot-free." In such a case the liability of the landlord is limited to the payment of the rate. This system is in force on Pevensey and Romney Marshes, but in the case of the latter does not extend so far as Hythe. In some places the landowners have to keep the sea walls or groynes in repair themselves, and can be compelled to do so if their neighbour's property is in danger. Again, as for instance on the coast of Essex, there is no obligation of any sort. Here unfortunately there are large tracts of reclaimed land, which have within recent years reverted to marsh, the cost of maintenance of the sea walls exceeding the rents received. The embankments to tidal rivers are, as a rule, supervised by local commissioners, who either carry out maintenance works themselves or direct the owners of river frontages to execute them. As an example of the latter system, it may be mentioned that two or three years ago the War Office was called upon by the Thames Conservancy to raise the embankments on the shore of the War Department property at Tilbury, which were insufficiently high. The Board of Trade exercises a supervision over all foreshores as regards impediments to navigation.

At the present moment a Royal Commission is enquiring into all matters connected with coast erosion, its causes, the best methods of

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protection, and the question of the incidence of cost. As regards the last named, representations have been made by interested parties chiefly, that it is a national duty to keep the sea out. It is however questionable whether individual landowners can legitimately claim to have their property protected and increased in value at the expense of the State. When the report of this Commission is published, it will no doubt contain a great deal of valuable information. Whether any Royal Engineer officer will ever see it is, however, a matter of some doubt. In any case it is hoped that in the meantime the remarks made in this Paper may prove useful to any officers who may, without previous experience, suddenly find themselves called upon to deal with the very difficult subject of foreshore protection.

CAUSES OF EROSION.

The sea coast has throughout all ages been subject to the attacks of the waves, the currents, and the weather, no matter whether the shore is mud, sandy dunes, chalk, or seemingly everlasting granite cliffs. If left unprotected, and the land is not raised from below, erosion is certain to occur ; it is a mere question of time.

Apart from the material of which it is composed, a coast will generally be of one of the three following natures, viz. :—

A. Cliffs, high or low.
B. A more or less level plain, slightly above sea level at high water.
C. Marsh land, probably reclaimed, below high-water mark, protected from flooding by artificial embankments or a natural beach of greater height than the general marsh level.

The forces acting on the coast line are :—

(*a*). Rain, frost, and wind, degrading the face of cliffs where they exist, and causing the rock or earth of which they are composed to fall on the beach, whence the *débris* is washed away by the sea.
(*b*). Direct action of the waves, eating away the base of the cliffs or the embankments.
(*c*). Littoral drift of sand or shingle forming the beach, due to oblique action of the waves or to tidal currents parallel to the shore.

The material of which cliffs are composed may be either the hardest rock, as in Cornwall and Pembrokeshire ; chalk, as in Kent ; sand, as in Hampshire ; or clay, as in Essex.

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The erosion of rock is so slow that we cannot measure it; certainly it has occurred on a vast scale, but the human mind is incapable of appreciating the number of years the process must have been going on.

The degradation of chalk is comparatively rapid, and may amount to a setting back of the coast line by a mile in a thousand years. It is probably due rather to frost and rain bringing down the face of the cliff than to direct action of the sea. Waves have really little effect on hard chalk *in situ*. There is a plot of W.D. land on the top of a cliff at Broadstairs. Under this plot is a cave worn out by the sea, and someone cut his name and the date (1847) in the chalk at the side of the cave. The inscription, now 60 years old, is still perfectly legible; it is, of course, protected by its position from the rain and frost.

The resisting powers of sand, loam, and clay, forming cliffs are of the slightest. These materials not only yield to the weather, but are also undercut by the waves with great facility, and unless protected artificially, their degradation proceeds with extraordinary rapidity. Cliffs of earth or clay suffer much more from the effects of land drainage and rain than from the action of the sea. The face is constantly being washed down on to the beach, and is carried away by the sea. This is well illustrated on both sides of Scarborough.

A coast line coming under the heading B, as described above, is not liable to be affected by weather; its only enemy is the sea. Moreover, the waves in their attack frequently provide a defence against themselves by piling up a high crest line of shingle or sand, aided, as regards the latter material, by the wind. There are hundreds of miles of sea shore in England and other parts of the world where the coast is fringed by sand dunes, forming an effective barrier to encroachment. These dunes frequently block the outlets to the drainage from the land, and cause shallow and sometimes brackish lakes to be formed behind them.

A shore coming under Class C must of necessity have been made artificially. It is found either where a tidal river running through marshes has been embanked, or some estuary has been reclaimed by the construction of a sea wall. Some of the reclamation embankments still existing in England are very ancient. It is an ascertained fact that part at any rate of Romney Marsh was reclaimed as early as the Roman occupation, Roman remains having been found in many places. Sometimes the sea itself acts as the agent by piling up a bank of shingle to a higher level than the land, thus actually excluding itself. Such a bank is known technically as a "full."

Now if we consider the forces in action, those classified under the heads (*a*) and (*b*) above are sufficiently obvious, and need no further explanation here. When, however, we come to (*c*), the conditions are more complex, and subject to local considerations such as set of tides and prevailing winds. It is only possible within the limits of a

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short Paper to indicate generally and very briefly what may and does take place, with a few characteristic illustrations.

Along the coast of Sussex and the south coast of Kent we find very strong tidal currents, running generally parallel to the shore, due to the tides running up and down the English Channel, which rapidly narrows towards its eastern end. There are also strong parallel currents along parts of the east coast of England, caused partly by the flow into and out of estuaries, and partly by the main tidal flow being directed along the shore by the numerous banks and shoals some little way out to sea. The tendency of every flowing tide is to carry along with it the sand or shingle on the beach and lying some little distance below low-water mark. Similarly every ebb tide seeks to bring the beach material back again. If there were no winds, and if the ebb and flow currents were of equal strength, which is not always the case, the beach would not be permanently altered; each ebb would restore to it that which the flow had taken away. Such an equitable arrangement is however upset when there is a prevailing wind blowing either parallel to, or at an acute angle with, the shore. Then wind and tide, acting in the same direction, move a great deal more of the beach covering than would be the case were the tide alone at work, and carry it along with them. When the tide turns it has wind and waves against it, and is consequently prevented from bringing back all that was removed. It is obvious then that a wind blowing constantly in one direction must cause a permanent transfer of beach material along the shore, the travel being in the direction of such a wind. This is what we find actually going on along the south and east coasts of England. The prevailing wind blows from the south-west in the one case and from the north-east in the other, and there is, except in places affected by local conditions, a constant movement of sand and shingle along the shore in easterly and southerly directions respectively. Groynes on the beach will be seen to have the material piled up against their western or northern sides, as the case may be. An easterly or southerly gale may temporarily reverse the state of affairs for a short time, but directly it ceases things go on as before. The shingle travels by rolling along the beach, and is worn smaller and smaller as it goes. Sand is mostly carried in suspension, and deposited when the current slackens.

The action described may be studied to great advantage at Dungeness and along the shore in that neighbourhood. On looking at the map (*Plate* II.) it will be observed that to the west of the Ness the coast line runs a little north of west, and east of the point its direction is at first due north, nearly as far as Littlestone, where it begins to trend off to the east. Now when the tide is flowing there is a very strong current all along the shore from beyond Hastings, and the prevailing south-west wind strikes nearly at right angles against the beach between Rye Harbour and Dungeness. The combined action of

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wind and tide causes a marked travel of the small shingle, of which the beach is composed, towards the extreme point of Dungeness. The tide then makes in a north-east direction for Dover, cutting across the bay on the east side of Dungeness, and the shingle getting into deep water comes to a halt. When the tide is flowing there is an eddy in the east bay, and the current sets from the direction of Dymchurch back towards the Point of Dungeness. We then get the curious fact that the beach is working from both sides towards the Point, and causing it to push its way out to sea a few yards every year. The beach is very steep at the apex, and there is deep water close in shore. This process has evidently been going on for a long period. All the way inland from Dungeness to Lydd there is nothing but a wilderness of shingle, stones, once forming part of some distant rocky or chalk cliff, fallen into the sea, and rolled for miles along the beach, to come to rest here. Back from the Point the eye can plainly trace a series of concentric curved ridges of shingle, each marking the crest of an old beach, as the rings in a tree indicate its growth. The same phenomenon may be observed on that dreary waste of shingle on the west side of Pevensey Bay known as the Crumbles, behind Langney Point.

Between the life history of Dungeness and that of Langney however there is a striking difference. Within historic times the former has steadily moved seawards and towards the east; the latter on the other hand has had alternations of accretion and recession. Pevensey was once a port, long since closed up by shingle moving eastwards from the Crumbles, whilst Langney Point itself has lost no less than half a mile in the last 170 years. East of the Point the present coast line, which is separated by half a mile of shingle from the old shore, is being eaten away rapidly, losing sometimes 50 yards in a year. Langney Fort, just east of the Point, has lost its gun emplacements within the last four or five years, and a heavy gale may any day destroy the remainder. It is difficult to find a reason for these changes in the action of the sea. In this particular locality there does not appear to have been within recent times any change in the level of the land, or, at any rate, none sufficient to explain what has been happening. Space does not admit of a discussion of this interesting problem within the limits of this Paper.

The travel of shingle along the shore materially affects the drainage of the land by closing or altering the position of the outlets of the streams and rivers. There are numerous instances of this round the coast of England. One of the most characteristic is to be seen near Aldeburgh, in Suffolk. Here the drift is from north to south. The River Alde approaches the shore at right angles, and formerly had its outlet just south of Aldeburgh. It still reaches a point within 80 yards of high-water mark, but the mouth of the river has been gradually deflected further and further south, so that we now see the

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Alde running at the back of the beach, and parallel to it, for no less than nine miles. The present mouth is south of Orfordness, and is no doubt continuing its southerly movement. The rapid accumulation of shingle is well illustrated by some old cottages on the beach at Aldeburgh, the ground floor rooms of which are now buried. The roofs are still on the houses.

A beach which is exposed to rough seas or strong currents, or both, is liable to great changes in its appearance within a very short time. A heavy gale in the direction of the normal movement of the beach material will accumulate in a day or two great quantities of shingle or sand. Should the gale be in the opposite direction, the beach may be entirely denuded of its covering, and the replacement of it may take months.

Some few years ago a severe storm washed all the beach out of Babbacombe Bay, near Torquay, leaving a floor of bare and rugged rock. This was an unfortunate occurrence for the local boatmen, as it was no longer possible for them to land out of or launch their boats except in perfectly calm weather. It is believed that the beach has since restored itself.

Rough weather will alter the slope of a beach. Where the material is sand the angle of inclination is generally practically uniform throughout. The section of a shingle beach frequently takes the form of a semi-parabola, with its apex about high-water mark. The action of the waves works the shingle up to the top, where it accumulates. Sand does not adopt this section, partly because it will not stand at so steep an angle as shingle, and partly because when collected above high-water mark it is liable to be blown away.

It is impossible here to give more than a very brief account of what is known as "littoral drift." Officers who have to deal with problems of coast protection, and others who take a special interest in the subject, are referred to *The Sea Coast*, by W. H. Wheeler, *The Scenery of England*, by Lord Avebury, and other standard works.

For further information regarding that most interesting and much discussed locality, Romney Marsh, the following books should be consulted in addition to those just mentioned, viz. :—*Ancient Britain and the Invasion of Julius Cæsar*, by Rice Holmes, and *Lives of the Engineers*, by Samuel Smiles.

PREVENTION OF EROSION.

There is no subject on which the opinions of engineering experts differ more than that of the means of protecting the land from the sea, no matter whether it is a question of the particular section for the face of a sea wall, its method of construction, or the form of groynes.* In the year 1904 the leading authorities in England joined

* *Minutes of Proceedings of the Institution of Civil Engineers*, Vol. CLIX.

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in a discussion at the Institution of Civil Engineers. Many of them had been engaged in coast protection their whole lives; all had different methods, and each was convinced that his was the right way, and all the others were wrong. The result of reading this discussion is that it leaves one's mind in a hopeless fog. The question however should be treated in a scientific way. From the evidence brought forward in this discussion by each engineer, we should try and discover not what he did so much as why he did it. Possibly then it may be judged which particular system is likely to be suitable for adoption, having regard to the local conditions of the part of the coast we may have to deal with. People are very apt to attach an undue importance to their experience. The saying *experientia docet* may be very true, but it has its limitations. It does not follow that because a man has been doing a certain thing all his life he has been doing it the right way. Even though he may not have had failures, it is conceivable that by going outside his trusted experience he might have attained better results. It is unfortunately but too true that the history of the construction of sea walls in England is a record of failures rather than of successes, although in many cases the most talented engineers in the country have been engaged to design them. This is no reflection on the professional ability of these gentlemen, but indicates either that the impossible has been attempted, or that the problem has not yet been solved. Very large sums of money, found by ratepayers, have been expended on protection works, every penny of which has at some unfortunate places been literally cast into the sea. At many watering places the maintenance of the esplanade is really a matter of life or death to the town. Its destruction does not mean merely the loss of the main attraction to visitors, but exposure of the town itself to the danger of being washed away by the sea. Hardly a winter passes without a tale of extensive damage to some esplanade or sea wall, built at great expense. Where a wall is constructed to serve the double purpose of keeping the sea back and of affording a promenade, it may be its own undoing. In order to gain space it is often built some little way down the beach instead of at or above high-water mark, with this result, that instead of causing the beach material to accumulate against its face, the sand or shingle may disappear, leaving bare clay, when the undermining of the foundations of the wall rapidly follows.

It has been said of Acts of Parliament that none was ever passed which effected all that was expected of it, or which did not have some entirely unforeseen result. This remark applies very aptly to schemes for coast protection works, the unexpected being usually of a painful nature. The Corporation of Scarborough has had an unpleasant experience of the kind described, having spent £150,000 on a "Marine Drive" round the Castle Hill, connecting the north and south bays. The work was supposed to be completed in October,

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1904. Owing to damages caused by the sea, the drive is closed to traffic at the present moment.*

Earlier in this Paper the different descriptions of coast which may have to be protected have been classified under three heads:—(A), Cliffs; (B), Low Shores; (C), Embankments, or natural beaches protecting marshes below high-water level. The attacking forces were classified as (*a*), Weathering; (*b*), Direct Action of Waves; (*c*), Littoral Drift. Having now considered the nature of our fortress and what our enemy is like, it behoves us to scheme our defence, bearing in mind that military tactics must not be followed too closely, and that salvation lies rather in "passive resistance" than in the "offensive-defensive." We are not considering reclamations, which of course are offensive operations.

Now there are two methods of staving off encroachments, which may be employed either separately or in conjunction. These are the direct and the indirect. By the former we mean the construction of continuous walls, more or less massive according to the violence of the waves which has to be resisted. The indirect method is that of employing the waves and currents themselves as an active agent in building up defence works in the shape of accumulations of shingle or sand as a bar to encroachment. This is effected by the construction of groynes on the foreshore, usually at right angles to the coast line. Groynes are frequently erected in front of sea walls, and we then have the combined system.

At first sight it may seem a vain thing to place lines of obstacles in the direction of the attack and not at right angles to it, and were there no tides or currents it would be so. Our object is, however, to hold up and retain the material, sand or shingle, brought up by the sea and moving along the shore under the influence of the littoral drift.

The aim of the engineer is to get his beach well covered, with no bare bones exposed to view, but as great a depth of sand or shingle as possible. The Walrus and the Carpenter, though experts in oysters, were not appreciative of this desirability:

> They wept like anything to see
> Such quantities of sand:
> "If this were only cleared away,"
> They said, "it would be grand!"

The carpenter at any rate should have known better. Perhaps though he was out of a job, and wanted to be employed making groynes to bring the sand back again.

Sea walls are very costly to construct and to keep in repair. They are usually adopted where it is desired to form promenades, as at

* Since these lines were written the "Drive" has been thrown open to the public.

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most watering places, to protect the foot of cliffs from being undercut, and to carry railways round the coast, as on the Holyhead line, the Great Western Railway between Dawlish and Teignmouth, and elsewhere ; also on certain parts of the coast where the action of the sea is particularly violent, or a breach would be peculiarly disastrous, as at Dymchurch in Romney Marsh. The term sea wall as used above is intended to mean a solid wall of masonry or concrete, but earthen or clay embankments faced with stone or chalk are popularly called sea walls also. There are many miles of banks of this description on the shores of Essex, in the Thames and Medway, and in numerous other places.

It is hardly likely that an English military engineer would be called upon to design or construct any extensive masonry sea wall. Unfortunately, those who rule over us do not see fit to employ Royal Engineer officers of civil works of public utility, as is the custom in the United States, the government of which has recently placed the completion of the Panama Canal in the hands of military engineers. It is not proposed, therefore, in this Paper to go into details of construction, or to discuss the much debated question of the type of cross section. All these matters will be found fully set forth in Wheeler's *Sea Coast*, already referred to, and elsewhere.

There are, however, numerous existing walls which Royal Engineer officers have to maintain, some of them giving much trouble, *e.g.*, one at Hythe, also a long stretch at Harwich ; the latter fortunately giving cause for little anxiety. There are certain dangers to which sea walls are liable. The toe is subject to insidious attacks, not so much from the direct beating of the waves when the tide reaches it, as from the backwash caused by the water running back off the face of the wall and scooping out the sand. This danger is usually combated by the construction of a stone apron some way down the beach, which often forms a continuous curve with the face of the wall. These aprons require very careful watching and examination after every gale. There are always a certain number of open joints through which the backwash finds its way and carries off the sand, leaving hollows beneath the masonry, and into these the stone falls. It is not unusual to see stacks of stone and timber piles at intervals along the top of a wall. These are kept in readiness to carry out instant repairs when necessary. The piles are required for driving into the sand at the foot of the apron, to prevent it from sliding down the beach. Another danger is that due to waves in heavy storms washing over the top of the wall and carrying away the backing. If this occurs a breach is certain to follow quickly. The surface of the ground behind the wall should, therefore, be covered with concrete, asphalte, or some other material strong enough to resist the breaking waves falling on it, and impervious to water.

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Flanks of walls are a weak point. They should never be "in the air" if it can possibly be avoided. It will almost always be found that the face of a wall is in advance of the line of the natural top of the beach, and therefore where the wall comes to an end a corner is formed. In such places the action of the waves is peculiarly deadly in its effect on the beach, and constant care is required to prevent the flank of the wall from being turned by the sea getting behind it. There is one such danger point at Dymchurch Redoubt, at the eastern extremity of the Dymchurch sea wall.* The jurisdiction of the commissioners who supervise Romney Marsh ends, on the eastern side, where the wall does. For 200 or 300 hundred yards to the east the frontage to the sea belongs to a private owner, and then that of the War Department begins, and extends to Hythe. This short length in private hands contains, perhaps, the weakest point on the shore of the marsh, and in order to save its own property from damage the War Office has been forced to undertake its protection by constructing groynes. In spite of these precautions the sea made a breach about four years ago and flooded a large area. We have here a striking instance of the unsatisfactory state of the law, or rather absence of law, dealing with the maintenance of foreshores. The private owner referred to could not be compelled to provide groynes in front of his property, so the War Department had to do the work.

Further along towards the east we come to another length of wall, extending from Hythe to Sandgate. At its western end it is on W.D. land, and formerly terminated at a fort, which has been almost entirely washed away. The destruction of the fort has left the end of the sea wall exposed, and its flank has been turned by the sea, owing to the natural "full" being now some distance behind the line of the face of the wall.

Sea walls must of necessity come to an end somewhere, but care should be taken not to leave the termination abrupt. The wall should be sloped back gradually to high-water mark on the beach, so that there is no corner.

Besides walls of masonry or concrete, others of flimsier construction may often be seen, such as camp sheeting and piles, or even brushwood and hurdles. The former will be found, for instance, along the top of the beach at the well-known Felixstowe Golf Links. There is a good example of brushwood work just south of Littlestone, near New Romney. Here the 1-inch Ordnance Survey maps show a deep indentation in the crest of the beach half a mile wide, and of the same depth, behind the general line of high-water mark. Quite recently the gap has been closed by means of banks of sand, protected by lines of brushwood planted in the beach in front. Up to the present time the new works appear to be holding their own.

* *Vide Plate* II. The wall extends from the village of Dymchurch to the Redoubt.

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So far we have considered the method of direct defence against erosion and encroachment. We now come to the indirect method, *i.e.*, the employment of groynes. In considering this subject we find ourselves at once confronted with the great divergencies of opinion on the part of the experts. These are fully set forth in the discussion at the Institution of Civil Engineers previously referred to.* The points in dispute are whether groynes should be of masonry or timber, high or low, long or short, straight or curved, at right angles to the shore or at some other angle, and how far apart they should be spaced. At the risk of seeming tedious it is proposed to go into this contentious subject somewhat fully, and as no definite conclusions were arrived at in the course of the discussion referred to, which is therefore not of much practical value to the novice in groyne construction, but rather bewildering, I intend to set forth my own views. These may be right or wrong, but they are not nebulous, and in justification of what may be considered presumption on my part I may say that they are founded not only on the study of a great deal of literature on the subject, but also on personal observation and knowledge of the coast of England and Wales throughout nearly its whole extent from Yarmouth to Fleetwood. I have referred to no locality by way of example which I have not visited. With these remarks, I leave it to officers who may have to design groynes to adopt my recommendations or not, as they may think fit.

An explanation has already been given of the action of waves, tides, and currents in causing what is known as "littoral drift." The supply of the shingle and sand travelling along the coast is derived from disintegration of cliffs, from the bottom of the sea beyond low-water mark, and from old storage grounds such as the "Crumbles," "Dungeness," or the "Denes" at Yarmouth. In most localities the direction of the drift, though subject to temporary changes, is practically always in one direction. But for the obstructions to the flow of shingle, etc., either natural or artificial, we should find vast accumulations at the meeting points of tides.

Sharp headlands, deep bays, estuaries, and river mouths are natural obstacles tending to hold up the stream of shingle.

Breakwaters, piers, and groynes are artificial obstructions. Now take the case of a breakwater or solid pier running straight out to sea into deep water. It is plain that it must bring the shingle moving along the foreshore to a halt, and consequently we find an accumulation on the windward side, a much higher beach, also high and low-water marks farther out. The lee side is dependent for its beach covering on what is brought up from deep water, or collected by gales from a direction opposite to that of the littoral drift. It is not till we get some distance beyond the pier that we find a normal

* *Minutes of Proceedings of the Institution of Civil Engineers*, Vol. CLIX.

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beach section again. Incidentally it may be mentioned that breakwaters, harbours, and solid piers have a prejudicial effect on the shore, owing to their cutting off the supply of shingle in the manner described.

Groynes are, or should be, intended to intercept enough shingle to keep the beach at a suitable section and let the rest go on. They are familiar objects of the seashore, execrated by boatmen, a nuisance to visitors, as they turn a beach into a sort of steeplechase course, and popular only with those seeking shady places, screened from view. In their older form they are massive timber structures, frequently strutted on the leeward side with huge tree trunks, and with a difference of level between their two sides of sometimes 15 feet, or even more. The corporations of some seaside towns have constructed large masonry groynes resembling breakwaters, which are a still greater obstruction to the beach. High timber groynes, and those of masonry or concrete, may be unhesitatingly condemned. They are expensive to construct and maintain, and pernicious in their action. At Eastbourne some flagrant examples of high timber structures may be seen in front of the parade. Doubtless they were designed to arrest shingle and cause it to cover the foot of the parade wall, and act as a protection to it from the waves at high water. Owing, however, to their great height, the shingle is piled up into the angles between the face of the wall and the groynes on the windward side, and there is a deep drop down on to the beach on the other side. The covering to the foot of the wall should be of a uniform depth; as matters are, there is a great deal too much in some places and too little in others. Moreover high groynes cause a nasty sea, and the waves tumbling over, tend to undermine them, and scour away shingle where there is already an insufficiency.

High groynes are immoral in principle. There is only a limited and fairly constant supply of shingle travelling along the shore, and if an undue quantity is arrested in one locality, the beach beyond must suffer from a deficiency. That this is so is demonstrated on a large scale at Dungeness, though in that case the stoppage is due to natural causes. There the shingle comes from the west, and on that side of the Ness which acts as a natural groyne there is plenty of it. On the east side of the Ness there is hardly any; the beach is almost entirely sand, and the shingle only begins again in any quantity some miles to the east. Corporate bodies have proverbially no consciences; their only care is to bolster up their esplanades, and if this is done at the expense of their neighbours, they reck not.

On a properly regulated beach the contours should be parallel to the shore line. This ideal condition is only attained when the levels on both sides of the groynes are the same, and obviously, therefore, they should, at any rate when first constructed, be low, so that the arresting and accumulating of the shingle may be gradual, and be

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distributed over the whole length of beach which it is desired to improve or protect. A series of parallel high groynes will collect all the shingle at the windward end, and little or none at the other. When a beach has, by the construction of groynes, been brought up to a proper cross section, very little of them should stand up above the shingle or sand; any portion that does so project is not only useless, but remains a nuisance; it is moreover likely to cause eddies and scour.

The first thing to do then in designing a groyne or series of groynes, is to take a cross section of the beach, showing its existing level. Above this should be drawn the section line which it is desired to obtain. The height of the posts or piles to which the boards are to be fixed should be arranged so that their heads are slightly above the ideal section.

In constructing the groyne the boards should be put in so that only two or three of them stand above the existing beach level. As the material collects more boards should be put in by degrees until the groyne reaches its final height. This method of gradual construction, besides ensuring an accretion of material along the whole length being dealt with, also disposes of the risk of destruction should a gale spring up before the new work has acquired any protecting covering. It must be borne in mind that adding to the shingle on a beach may have the effect of moving both high and low-water marks seawards, and that it may be desirable to extend the groyne so as to keep its lower end always at low-water mark.

It may be objected that this piecemeal construction is difficult to carry out under a system of annual allotments of funds. The difficulty may be got over by driving all the piles and purchasing all the boards in one financial year; the cost of putting the latter into position when required later on is practically *nil*.

Having now, it is hoped satisfactorily, disposed of high timber and masonry groynes, I propose to consider the question of length. It may be laid down as a general rule that each groyne should extend from high-water mark, ordinary spring tides, to low-water mark. Failing this, shingle and sand, which might with advantage be intercepted, will pass by and be lost. This rule has not been generally observed. Nearly everywhere that the coast is protected by groynes, especially where they are old, short lengths are to be seen. Sometimes they extend for a short distance down the beach from high-water mark, at others up the beach from low-water mark. This mode of construction is only justifiable where there are longitudinal hollows or depressions which it is desired to fill up. Such depressions are not infrequently found on sandy beaches, and may be seen forming pools when the tide has left them. Short groynes are often interspaced between long ones. It is difficult to understand the principle leading to the adoption of this arrangement; probably it

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was due to some notion of economy. A much better result would usually have been obtained by constructing the groynes at wider intervals and making them all long. Possibly it may have been discovered that the long groynes were spaced in the first instance too far apart, and the short lengths were interpolated subsequently. If this were so, the new groynes should have been the same length as the others.

It has been stated above that groynes should be carried down to low-water mark, spring tides. Where there is much scour on a beach, it is advantageous to carry them out farther still. Sand in suspension being carried along by the current beyond low-water mark will then be captured. Shingle, unless very small, is drifted by the striking action of waves, and its movement is mostly on the foreshore, *i.e.*, above low-water mark. Recent investigations have however shown that the effect of waves is felt at a much greater depth below the surface than was formerly supposed, and is capable of causing the lateral movement of shingle considerably beyond low-water mark. Some engineers have even recommended that heavy chains should be secured to the tail ends of groynes and carried straight out to sea. It seems doubtful whether the result would justify the cost of this arrangement.

The next point for consideration is whether groynes should be straight or curved. The idea that they should be curved is probably a survival of the exploded notion that a bellying sail holds the wind better than a flat one, and it may be relegated to the same limbo. Curved groynes would be a much greater nuisance on a beach than straight ones. Boats coming ashore require a straight run up, which they can find between straight groynes without difficulty.

As regards the question whether groynes should be at right-angles to the beach or oblique, there is great difference of opinion, usually expressed with force. Many capable and experienced engineers say that they should be more or less at right-angles to the set of the waves on the shore. Suppose a shore line runs east and west, that the set of current is parallel to the shore, and that a south-westerly wind is blowing. The resultant of these two forces will give the direction of the drift of the shingle, and it is argued that groynes should be at right-angles to it. This sounds plausible, but I am not at all sure that there is much in it. Oblique groynes get in the way of beaching boats nearly as much as curved ones. On the whole, I should say, unless there is some strong local reason to the contrary, make them at right-angles.

Distance apart must be dependent on local considerations, no hard-and-fast rule can be laid down. It is fairly obvious that unnecessary expense is incurred, and no good done by erecting groynes too close together. Only in exceptional circumstances should the distance apart be less than the length, or the horizontal distance between

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high and low-water marks. As has been observed earlier in this Paper, it is not possible to forecast with great accuracy what actual result will be obtained by protection works. If there are no other groynes existing in the neighbourhood under similar conditions which can be inspected, a tolerably safe rule will be to space new groynes at distances apart equal to twice their length. If subsequently found necessary, intermediate groynes can be interpolated without being too close together.

When once erected groynes should receive the most careful attention. They should be inspected frequently, and always after heavy gales. Damages should be repaired at once. Breaches left unattended to are almost certain to cause a mischievous scour.

Another important duty is that of keeping record plans and cross sections, on which the state of the shore is noted periodically. It is no use spending money on protective works unless an accurate record of the results obtained is kept. Royal Engineer officers and subordinates are not like those in civil employment, who may remain in the same job for years and carry its history in their heads; it is, therefore, all the more necessary that accurate plans of the shore should be kept up to date.

Having so far dealt mainly with principles, it is proposed now to give some details of construction. Nothing will be said about the massive timber structures forming high groynes. As regards low groynes, the use of which has been advocated above, it does not matter much how they are made so long as they comply with the condition that in the first instance they are not more than one or two feet above the beach, and that as the material is accumulated more boards can be added. The simplest plan is to drive piles in pairs with a space between them equal to the thickness of the boards, and at distances apart from centre to centre equal to the length of the boards. It is better to step the groyne up the beach, and not set the boards at a slope. The piles must be left high enough above the beach to leave space for the addition of boards as may be necessary to attain the desired section. About three years ago the Royal Engineers erected some groynes near Hythe. Instead of piles, piers of masonry in cement were employed, chases being formed in their sides, into which the boards were slipped. I do not recommend this system; it is expensive, the piers are terrible obstructions on the beach, and they are subject to scour. Also, they are liable to get out of upright, and it is then impossible to put any more boards in.

*In 1896 a patent was taken out by the late Mr. E. Case, then engineer of the Romney Sea Defences, for his system of groyning. He advocated the principle of making them low in the first instance,

* *The Sea Coast*, Wheeler, p. 124.

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and raising by degrees. The patent really only applied to the manner of fixing the uprights. Instead of driving piles, Mr. Case fixed his uprights in blocks of concrete sunk in the beach. Subsequently the claim was upset by the Court of Appeal.

As regards the scantlings of timber used, where there is likely to be a heavy sea the piles may be 9 inches square and the boards 3 inches thick; elsewhere 6-inch piles and 2-inch boards will be sufficiently strong. The piles should be driven at intervals of from 7 ft. 6 ins. to 15 feet, and should if possible go down into the clay, especially when driven through shingle which is always on the move.

The Case system of setting the uprights in blocks of concrete is more suitable for a sandy beach than for one of shingle. *Fig.* 1, *Plate* III., shows a section of a beach and a groyne. The beach as drawn is unusually steep; a flatter slope would have necessitated an unwieldy plan being printed, and would not have illustrated the principles laid down quite so clearly. It should be noted that the boards indicated by dotted lines are to be placed in position one at a time as the beach fills up. Details on a larger scale are shown in *Fig.* 2.

Cost of construction must necessarily vary according to local conditions. It will depend on the distance apart of the uprights, length of piles driven, scantlings of timber used, and very much on the accessibility of the place of erection. Sometimes groynes have to be constructed in very out-of-the-way places to which there is no road, and the cost of haulage then becomes a serious item. Wheeler quotes 16s. 9½d. per yard run for low groynes with piles, and 19s 2½d. for "Case" groynes.* Mr. E. R. Matthews estimated the cost of low timber groynes proposed to be constructed near Bridlington at 13s. 6d. per foot or 40s. 6d. per yard,† the piles being 7 ft. 6 ins. from centre to centre. The only reliable way, however, of forming an estimate of the cost of a new groyne is to take out the quantities, and to provide for the full height which it will eventually reach. On *Plate* III. is given a cross section of a beach showing existing surface, the desired surface, and a groyne.

As has been already mentioned supervision of all foreshores is exercised by the Board of Trade. Before therefore proceeding with any protection scheme it is necessary to obtain approval of the Board through the War Office, submitting with the application plans of the proposed works. This fact is not generally known to Royal Engineer officers, and neglect to procure the sanction required may lead to serious trouble afterwards.

In an early part of this Paper allusion has been made to Romney Marsh and the growth of Dungeness. I am indebted to the C.R.E.,

* *The Sea Coast*, p. 124.

† *Proceedings of the Institution of Civil Engineers*, Vol. CLIX., p. 74.

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Dover, for the map reproduced (*Plate* I.), which illustrates admirably the remarkable changes which have taken place in the topography of this most interesting neighbourhood within historic times. *Plate* II., reproduced from the most recent Ordnance Survey map, is given for the sake of a comparison. The old surveys from which the map reproduced in *Plate* I. was traced were not altogether accurate; it will, however, serve the purpose.* The first part of Romney Marsh to be enclosed was that lying to the east of the road from New Romney to Snargate. This road runs along what is known as the Rhee Wall. When and by whom this wall was made is not known. As Roman remains have been found to the east of it, certainly it is not later than the Roman occupation; it may be much earlier. Prior to the reclamation there was probably a bank of shingle extending from Littlestone past Dymchurch and reaching to Hythe, which place was a port till the shingle closed the entrance, in comparatively recent times. It is claimed by some authorities that Lympne was also a port in Roman times, and was, in fact, "Portus Limanis"; there is, however, good reason to believe that this assumption is erroneous.† However that may be, there is no question about Appledore having been accessible by water. The Danes landed there in 893,‡ and the map given in *Plate* I. clearly shows the sea reaching it. Rye is still reached by small craft, but has lost much of its importance. The original site of Winchelsea is said to be under the sea, the town having been overwhelmed by a storm in the year 1250.§ The present town was built to take its place, and stands on a rock. On the map given in *Plate* II. will be seen Camber Castle south of Rye, built in the reign of Henry VIII. It is similar in design to Walmer Castle, and is now in ruins.

On the map in *Plate* I. the growth of Dungeness is clearly shown. This map however shows the Ness as having once been considerably more to the west, and with its axis running nearly north and south. It is difficult to accept this as a correct representation, and I think it may safely be rejected.

In conclusion, I venture to express a hope that this Paper may prove useful to those of my brother officers who may be called upon to carry out the construction or maintenance of works for the protection of the coast from erosion. I would recommend them also to provide themselves with the book to which I have several times referred, viz., *The Sea Coast*, by W. H. Wheeler, published by Messrs. Longmans, Green & Co. in 1902; price, 10s. 6d.

* It will be observed that Dymchurch is shown below the line of high-water mark, 1736.

† *Ancient Britain and the Invasion of Julius Cæsar*, Rice Holmes, p. 543.

‡ *The Scenery of England*, p. 159.

§ *The Scenery of England*, p. 159.

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THE RELATION OF COAST DEFENCE TO HOME DEFENCE AS A WHOLE.

By COLONEL S. A. E. HICKSON, D.S.O., R.E., *p.s.c.*

MAJOR MOLONY tempts me to write again, and the desire to be clearly understood on the questions recently raised in the *R.E. Journal* must be my apology for again appearing on this subject. I am especially anxious to correct the impression that I have at all advocated "Forts," "Chains of Forts," or permanent works of any kind. But we have got a chain of naval bases to defend, and, in my own words, "my proposals are the natural result of the development of artillery in accuracy, range, and rapidity of fire; and the question raised is nothing 'revolutionary,' but merely whether under the new conditions the best line of defence against land attacks may not be on the flanks of our naval bases, instead of round them." My endeavour was mainly to invite especial attention to the immense advantage now afforded to guns by a coastal, as compared with an inland artillery position, in point of this rapidity, accuracy, and range, besides field of view and fire, and immunity from any serious reply on the part of an enemy on the sea, intent on effecting a landing. In the latest edition of his book on fortification Sir G. S. Clarke indicates that "the 6-inch gun with an auto-sight will far surpass, in speed and accuracy of fire, the possibilities on board ship. The latest war experience plainly shows that frequency of hitting is now, as always, supremely important, and it is from this point of view that the 6-inch gun, which is doubtless capable of further development, must be regarded as well suited for coast defence." The result and development foreseen are now in process of being achieved, even beyond expectation; and as regards this *special combination of accuracy and rapidity*, even up to considerable ranges, the destructive power of small and medium guns, field and fixed, especially the 6-inch, is now immensely superior in an elevated coast position, as compared not only with similar guns on ships, *but inland*. This superiority is so great that it may well be called, at the present time, the distinguishing feature of Coast Defence. The high fixed vertical base obtainable by guns on cliffs, such as prevail on our south coast, firing over a clear fixed horizontal plane — the sea — with the latest developments of sights and range-finding apparatus, are mainly responsible for this result. On ships, though rapidity is possible, there is not sufficient vertical base for accuracy. Inland the vertical

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base varies with every target, and, as hostile fire precludes the use of direct fire with advantage, concealment becomes essential. Speaking broadly, direct fire and a vertical base are as essential to coast artillery as concealment and indirect fire are to inland guns. Neither indirect fire,* which is practically useless against a rapidly moving target, nor concealment play a conspicuous part in coast defence, where a sufficient base is procurable. The modern accurate sighting system is there all-important, considerably more hits than misses being secured by the 6-inch gun at very great ranges with astonishing rapidity. Thus it is hardly too much to say that one such fixed gun, with its detachment well placed on the coast, has five to ten times the destructive power of a similar gun placed inland. In other words, *two hundred artillerymen behind guns well placed on the coast on the flank of a defended harbour are equivalent to something like an inland garrison of from* 1,000 *to* 2,000 *men manning guns on its land fronts.* The moral is that to go forward on those flanks, where favourable places exist, is politic and economical. This is not only an R.E. opinion, and not only my own inference. It is a line of argument which must be well grasped in discussing coast defence at the present time, and seems generally admitted by those experienced in latest results.

In applying it, I have hitherto confined myself to my own *metier*, which is harbour defence, attempting to utilize this coastal advantage more particularly on the south coast, which is so suitable, and where we have, as said, already a "chain of naval bases." Reliance on the naval defence of such excellent landing places as Torbay and Folkestone, so threatening to the harbours they adjoin, seems indeed an expensive and questionable policy, seeing that not only is free offensive action claimed for the Navy, but we are deficient in small craft, whilst, as Sir G. Clarke states, "The lessons of war prove that coast defences, so called, almost invariably fall as the result of a land attack, and that even when they are technically contemptible they serve their purpose." Doubtless if such places were defended on our south coast, we should have an almost continuous line of coast defence, but I have not myself advocated such a system as of universal application. On the east coast, for example, we have no naval bases north of London, and I have not dealt with this case.

It is clear, however, that some officers, considering that, as Major Molony says, "even our best fortresses have large gaps in their defensive circuit," realize that the field army or a part of it must move forward towards the coast line when those naval bases are threatened. One thing is certain, that we cannot "concentrate" our

* Whether firing direct or indirect, the 18-pr. field gun, firing shrapnel, may be more rapid than the 6-inch or other guns, when once the range is found; but the advantage of direct as compared with indirect fire still remains.

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naval bases. We cannot pick them and their garrisons up, and put them all under one hat and sit upon it, or stand in front of it, or surround it with our little untrained force. To some extent we are committed to being "strong everywhere" by having to defend our naval bases, arsenals, and ports. Platitudes will not help us. Napoleon did not perpetually spout them. But he was a master of art, and he applied principles with common sense, being very careful always to have something worth "concentrating." This, too, should be our endeavour. If, moreover, there is to be co-operation, then clearly harbour defence is inseparable from coast defence, and coast defence inseparable from home defence; and as both Major Molony and Capt. Walker indicate, the only question is one of relative value and proportion—What is the correct relation between harbour defence and coast defence with regard to home defence as a whole?

We are thus, once again, brought face to face with our old friends the canons of all art—unity, proportion, and relative value—which so inevitably save us from riding wild hobbies, or from running amuck amongst desperate extremes. As already said, my own aim has hitherto been to keep strictly to the province of harbour defence, and I am fortunate so far in having, on the whole, the able support of Major Molony and Capt. Walker. But they, and perhaps, others, going further, seek to solve this relationship between coast defence (including harbour defence) and home defence. Putting aside the Blue Water School, and all extreme views, or such contentions as those of Sir George Clarke that a force of 40,000 men and 4,000 horses would "require at least 136,000 tons of shipping or 27 vessels averaging 5,000 tons,"* their desire appears to be to devise a general scheme of home defence, founded on what is *possible* in the way of invasion, rather than on what merely seems probable, since, as we have recently been told on high authority, "the bolt of war has often fallen from a clear sky." If, then, the proposal is now to propound a system of defence suitable against surprises and great emergencies, bearing in mind such notable events as Aegispotami, the crossing of the Alps by Hannibal, Constantine, and Napoleon, Ulm, the Norman Conquest, and our own temporary loss of the sea and of America, then I concur with Major Molony and Capt. Walker, and I think that here Major Harrison, and even "Forts," will be in agreement too, that the first point to settle is strength and distribution. Our aim should be to get the help of as many as possible of our inhabitants, not only inland, but on the coast; and to establish, for mutual co-operation, as has been so soundly suggested by several officers, the correct relation between coast defence and the field

* One wonders what tonnage Henry V. allowed when he landed at Harfleur with 30,000 men, cut himself off from his base, fought Agincourt, and eventually conquered France. Great men take great risks. The defences of Harfleur were weak.

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army as factors of home defence on land, remembering that the first function of the Navy is offensive action at sea. Coast defence thus becomes merged in the larger subject of home defence on land; and, to secure unity and efficient co-operation we must, as a first step, fix the proportionate distribution of our forces as a whole with regard to the several parts, *i.e.* :—

1. The Coast.
2. The Supports.
3. The Reserve or Field Army.

Obviously the first question that arises thence is—should the line of coast be our line of resistance, the field army furnishing supports and reserves to move up to the threatened point; or, should the line of coast be regarded merely as a line of observation, to give warning to the field army, so that it may take up the most strategically and tactically advantageous position in rear of the threatened point? We have to bear in mind that our Territorial Army is not to begin to train seriously till war is declared, and that an attack may come like a bolt from the blue.

The schools of thought seem to divide themselves into two on this defensive question, as Major Molony has so clearly shown, *i.e.* :—

(1). Those who, accepting the orthodox view, propose to face the enemy when he marches inland, after landing unmolested at one of our "undefended" ports, such as Torquay or Folkestone, whose inhabitants have hitherto raised no objections to this visit of the invader to their homes.

(2). Those who—(i.) desirous of taking full advantage of the great power of modern weapons on the coast, (ii.) doubtful of the power of semi-trained troops to manœuvre, and (iii.) conscious of the need for sending, possibly, the whole regular army abroad on emergency—propose to endeavour to prevent a landing by defending the coast line, invoking the assistance of the inhabitants there, so easily capable of artillery training, in plugging the enemy with shell, instead of stuffing him with food.

Doubtless much may be said for the former alternative, though the advocates of the orthodox school do not seem to have enunciated the advantages they claim, and the once famous scheme for the defence of London is defunct. Major Molony has, however, skilfully propounded the advantages of the later idea, the arguments in favour of which may be summarized as follows:—

(1). That the coast affords an unmistakable and definite line of defence, requiring little knowledge of strategy and tactics.

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(2). That that position, above all others, is, therefore, especially suitable to semi-trained troops, little experienced in manœuvre in the field.

(3). That in that position the conditions most favourable to defence are attainable, more especially the maximum destructive power of artillery, bearing in mind that Sir G. S. Clarke tells us that the essence of a good defensive position is "that the weapons of the defender shall obtain the utmost possible scope of action, and that those of the attacker shall have the minimum chances of effecting injury."

(4). That we must defend our naval bases and dockyards, which *are* on the coast, and the land fronts of which are most vulnerable to attack by landings effected on their flanks.

(5). That mobilization tables are easily worked out and practised in time of peace for concentrations on any sea front in time of war, with the aid of railways, motors motor buses, and steam trolleys.

(6). That there is available on our coasts a magnificent body of men in the sailors and fishermen living there—men accustomed to danger and hardened to weather, who would as joyfully man a gun to beat off an enemy as they would man a lifeboat to rescue a friend.

(7). Men are more easily trained as coast (fixed) artillery* and infantry than to manœuvre.

(8). That political agitation along our coasts, unless visibly defended, is notoriously apt to dangerously affect our naval policy, and we are weak in small naval craft.

These heads, I think, include all the advantages claimed by Major Molony. As regards distribution, I understand that he recommends (taking the Territorial Force as his basis)—

(1). One-third of the infantry to be entrenched within rifle shot of the beach.

(2). One-third to form mounted brigades in support, conveyed in motors, bicycles, buses, etc.

(3). One-third to be put at the railway junctions behind the coast.

What proportion and nature of artillery he recommends, except in Kent and Essex, I cannot find, but he recommends much more coast defence artillery than we have, in which I concur, though he states: "I should not propose to put troops on the coast till an invasion is

* Herein lies the difference between fixed coast artillery and field artillery, which latter arm, as Lord Roberts has just pointed out, requires very special training to be efficient.

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actually threatened." As regards such a scheme generally, we labour at present under a two-fold difficulty, first, in not knowing what force may be available; secondly, as Major Harrison has pointed out, in not having any standard enemy. We might do as the Navy do, and adopt a one, two, or three-power standard. But even so we could not possibly fathom the strength of enemy likely to be brought over on an unexpected development; so that our scheme must be very general and calculated as far as possible to face the worst contingencies—the bolt from the blue. Here I concur also with Major Harrison, whose view I take to be that, on principle, we ought to have an expansive system, on a self-supporting basis, capable of including on emergency our whole able-bodied manhood for national defence, so that as many men as needful in any threatened part may be called up. Those who study history are aware that this actually was at one time our national system. "The maritime counties, even under Edward I., were liable for the charges of defending the coast."* More interesting still is it, as many may have noticed, that a large proportion of Militia battalions are said to have records dating from 1539. In that year we were threatened with invasion by Germany, and the French Ambassador of the time writes: "I found *every English subject* in arms who was capable of serving. Boys of 17 or 18 have been called out, without exemption of place or person."† 15,000 men of London in three brigades marched past Henry VIII., all in white uniform, headed by the Mayor and Aldermen "in white armour, with light coats of black velvet. Massive gold chains hung on their breasts. Their caps were of velvet, with plumes; and steel battle-axes were slung at their side."

Major Molony's scheme is doubtless on sound lines as far as data are available at present, but I suggest considering—

(1). Fixing first the number of coast brigades necessary to sufficiently retard any surprise landing, according to the facilities afforded by each portion of the coast for coast defence weapons.

(2). Fixing then the number of mounted brigades required in support between some such line as Taunton, Salisbury, Aldershot, Yarmouth, and the sea.

(3). Finally distributing the remainder as field army centrally at mobilization stations behind each front, such that any front could be easily supported in rear by sufficient strength, the total strength of the force being determined accordingly.

* Stubbs' *Cons. History of England.*
† Froude's *History of England.*

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Artillery should, I think, be the paramount arm of the coast brigades, and the strength of this arm required will not be found excessive, having regard to the high efficiency of coast artillery, and the facts already stated as to its destructive power. I concur with Major Molony that 9·2 guns are not required everywhere, though in some cases essential. Medium and small guns (fixed and mobile), machine guns, and rifles are the mainstays of coast defence. As regards, however, guns mounted on trucks on railway lines, the aim should be to secure direct fire for the reasons already given. Indirect fire might occasionally be suitable against anchored transports, and on very flat coasts, but the general artillery view, I understand to be, that to use it on the coast is to sacrifice the main advantages of coastal positions, and with this view I concur. The use of motors and motor buses was dealt with in a lecture by Colonel the Right Hon. Sir J. H. A. Macdonald, K.C.B., Honorary Colonel of the Motor Reserve—published in the *R.U.S.I. Journal* for April, 1907. Starting with the assumption that our aim must be to prevent an enemy from landing, and that "for this purpose the thing to be desired is that we shall be able to concentrate rapidly a fire force at the place where a landing is to be attempted," he proceeds to show, amongst other little items, that 1,500 motor buses could convey 275,000 men from London to Dorking (26 miles) in 30 hours; but the question of roads, crossings, and collisions is avoided. Nevertheless, recent elections have shown what organization can effect by utilizing motors. It is also noteworthy that 20 buses (sometimes available in provincial towns) can convey a battalion any reasonable distance with great rapidity; and the suitability of these and steam trolleys for concentrations on the coast may yet be practised at future mobilizations of the Territorial Army, and would create great interest.

In conclusion, may I thank Major Molony, Major Harrison, and others for their valuable suggestions, as far as I am concerned, though they have doubtless been put forward by them as a labour of love. Certainly, we cannot too much consider either the relation of coast defence to home defence, or of home defence to imperial defence, or the relative value of land as compared with naval coast defence.

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SOME NOTES ON AEROPLANES.

By CAPT. R. P. T. HAWKSLEY, R.E.

THE science of flight, as relating to machines whose support is based on the dynamic reaction of the air, has proceeded so far that it is now founded on real facts, on natural laws (which are, however, as yet only partly understood), and on a long series of experiments. During recent years these experiments have increased in number and importance, owing to the enormous advance in the manufacture of the internal explosion engine, and of materials suitable for supporting surfaces and other parts.

Although it is somewhat difficult, if not impossible, to obtain information as to the most recent experiments and successes, yet Chanute, in his *Progress in Flying Machines*, gives information on a large number of experiments. Most of these are of extremely little use, the earlier ones being certainly the work of visionaries who had not studied even the elements of the science, if indeed they were then in a position to obtain any data to commence on. Needless to say a great many of these men broke their necks.

The later experiments detailed by Chanute are, on the other hand, of great use, for it is in these that theory begins to join hands with practice.

Among the authors of the latter may be mentioned :—

Phillips (1884), who invented and patented the "dipping edge," which will be touched upon later.

Maxim, who made a successful experiment in 1892.

Lilienthal (1892), who personally made a long series of gliding experiments on aeroplanes of various shapes. He unfortunately lost his life, in an accident, during one of these experiments.

Langley, Duchemin, and Joessel were mathematicians and theorists, who framed most important laws as to pressure and so forth.

Among the more recent mathematicians who have investigated the subject is Lanchester, whose *Aerodynamics* is an exhaustive review of the science (one volume is published and a second is promised). The only drawback to this work is that Prof. Lanchester begins where most people leave off.

Chatley's *Problem of Flight* gives a mass of information, but is not everywhere entirely convincing.

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Navigating the Air, by the Aero Club of America, is a popularly-written work, and contains a proportion of useful information.

Among those who have of recent years made actual experiments, and gone up unto the air on aeroplanes, may be reckoned Santos-Dumont, the Wright brothers, and Farman, and the efforts and successes of these men have given the science an enormous impetus.

The following are some of the points which concern the design of an aeroplane:—

1. Lateral and longitudinal stability under all conditions of flight.
2. The shape of the machine and its parts.
3. The shape and area of the planes or supporting surfaces, in relation to the weight carried and the power generated.
4. Power, how generated and applied.
5. Starting and alighting.

The Wright brothers have made many flights of several miles, and have even made one flight of as great a length as 24 miles. On all these occasions the flights were made in perfect safety, and were only stopped by want of fuel, hot bearings, or some similar cause. Unfortunately, these flights have been kept so secret, and the machines have been kept so jealously from the public view, that very little is as yet known of the designs adopted.

Farman recently made a successful flight in Paris. In spite of his success, it is extremely doubtful if his machine has sufficient balancing power to render it even partly safe; and after all safety is the essential quality.

The fact however remains that successful flights have been made, and that all the conditions enumerated above—with the exception of the first—have been at least partially complied with. From this it is fair to assume that lateral and longitudinal stability is, at present, the main difficulty to be overcome in order to make the aeroplane of practical value. The remaining points, although partly solved, still require attention, and, perhaps, radical alteration.

Taking the points enumerated above in order:—

1. *Lateral Equilibrium.*—It is an established fact that a single plane of almost any shape, if provided with a following or guiding plane, will glide to the ground at a gentle angle, provided it remains laterally in a horizontal position. If however owing to a beam wind or to a deviation from the straight course, one side falls lower than the other, then nothing will prevent this motion continuing until the plane arrives at an angle where the resolved area is insufficient for support. It will then fall violently to the ground. This also applies if the plane is provided with power, and if there are tiers of planes in lieu of single planes.

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If however instead of one single plane, or a tier of single planes, there are substituted two planes, or tiers of two planes, set at a dihedral angle, ridge downwards and fore and aft, then the conditions are altered. The tendency is for the planes to return to their normal positions when disturbed, unless they are taken aback owing to a sudden side wind or shift of helm. If this happens and there is insufficient "helm," the result must be disastrous, as the supporting surface, by being taken aback, is so reduced that resistance to gravity becomes impossible. From this we learn :—

Firstly, that the centre of pressure of the whole machine, when viewed laterally, must be abaft the centre of gravity. This will give the operator some control over his machine, in that he can, in such a case, put his helm down and luff.

Secondly, in order to avoid the possibility of being taken aback at all, some automatic arrangement should be provided which will cause the planes to return at once to the normal position, if moved by a sudden disturbance. This automatic provision has as yet not been devised, unless, by chance, the Wrights have hit upon the correct solution of this difficult question.

Longitudinal Stability.—This is equally important, and can only be satisfactorily provided for by automatic means. Joessel, Langley, and Rayleigh have established the law relating to the centre of pressure of a plane. This law states that in a square plane, normal to the pressure, the centre of pressure coincides with the geometric centre, or centre of gravity, but, as the plane is inclined to the horizontal, the centre of pressure moves toward the cutting edge. The same law applies in a greater or less extent to planes of any shape or of any section, if indeed the term "plane" may be applied to a curved surface.

This disturbance gives rise to plunging when the machine is proceeding at a small angle of elevation ; and it is this plunging which must be obviated by automatic means, it being apparently not possible to control the movement by means of the rudder alone. No such means have as yet been devised, but automatically-moved weights or planes seem to be required.

2. *The General Shape of the Machine.*—In almost every case, except that of Langley's model aerodrome, experimenters have attempted flights with machines of large width and comparatively very small length.

Some have been close imitations of birds, and have been composed of a short body on which a pair of dihedral planes are fixed, or a series of superposed dihedral planes.

A further and smaller plane has been placed in front or rear, either acting as a steering plane or as a balancing plane, or both. A rudder in front or rear, but more often in front, has been provided, and propellers have been placed either in front or in rear.

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Owing to the extreme shortness of these machines, longitudinal stability must have been a matter of difficulty or of chance.

It is exceedingly doubtful if this type will survive, and all considerations seem to point to a much longer type being necessary, perhaps on the lines of Langley's machine. On the other hand, it must not be overlooked that in a machine such as Langley's, the efficiency of the planes and propellors in rear may be interfered with by those in front. It is necessary that the limits of this interference be determined by experiment.

The stream line theory must be considered in the design of suitable parts, such as the car, etc.

3. The shape of the supporting surfaces is a matter of considerable importance. In 1884, Phillips invented and patented planes with what is termed the "dipping cutting edge." This shape was also devised by Lilienthal and Lanchester in 1890 to 1894. These three authorities designed their planes somewhat thicker immediately behind the cutting edge than elsewhere. This shape, with modifications, seems to be adopted by all later authorities and experimenters.

It is curious to note the similarity between the curved plane and the "bellying" sail of a vessel. Phillips stated, in his specification, that in such planes the current of air struck the forward edge and was deflected upwards, thus causing a partial vacuum above the after surface of the plane. This theory, although it seems plausible, is said to have lately been discredited.

Joessel's law, as to the centre of pressure of a plane, points to the area of greatest pressure being always in front of the centre of gravity, hence the fore and aft length of the plane should be small, and the lateral width great, for any surface behind the centre of gravity must be more or less useless weight.

The proportion given in the later experiments is 1 to 5 or 1 to 6, but it is possible that even this proportion is too great. Phillips went so far as to propose a series of curved planes with dipping edges 1½ inches long fore and aft, and 22 feet wide laterally, the whole supporting surfaces somewhat resembling a Venetian blind. Holland, of submarine boat fame, suggested a similar arrangement. Such an arrangement of planes must be so designed that the after planes are not interfered with by the wake of those in front. It is obvious that the less the fore and aft length of a plane, the less will lateral currents of air be felt.

As regards the area of the supporting surfaces (in relation to the weight carried) the greater the velocity, the less area is necessary to support a given weight, but as this presupposes the machine to be in full flight, a minimum area must be determined upon for the purpose of starting a flight, whether from the ground or from a height.

This ratio can only be determined by experiment, and must

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depend to a great extent on the materials used. No definite decision seems as yet to have been arrived at.

Maxim	allowed about	$\frac{1}{2}$	square foot	per lb.
Santos-Dumont	,,	2	,,	,,
Phillips	,,	$\frac{1}{3}$	,,	,,
Lilienthal	,,	$\frac{3}{4}$	,,	,,
Hargreave	,,	$\frac{1}{7}$	,,	,,

As regards the relation between the power, weight, and speed, we have the following records :—

Maxim	22 lbs.	per H.P. at	30	miles per hour.
Santos-Dumont	9 lbs.	,,	24	,,
Wright	62 lbs.	,,	30	,,
Do.	53 lbs.	,,	34	,,
Do.	46 lbs.	,,	38	,,

If Wright's observations are considered, it will be noticed that the weight per H.P. varies inversely as the speed, as it should do. When high speeds of say 100 to 150 miles per hour are attained, the proportion of weight to H.P. will be greatly decreased, owing to the resistance of the parts of the machine, such as the car, etc.

Chanute assumes that 100 lbs. per H.P. can be safely sustained.

4. The power is, and probably will be, provided by internal explosion engines, actuating one or more propellers, until wireless power solves the difficulty. The "Antoinette" motors are the latest in use, and are made now as light as 2·2 lbs. per H.P.

In the case of steamships, efficiency to the extent of some 75% of the I.H.P. is obtained, and, of the loss, some 10% is due to slip. Owing to the lack of viscosity of the air, the slip in an aeroplane is a great deal more than in the case of a steamship, and is undetermined at present.

5. *Starting and Alighting.*—Most aeroplanes have hitherto been provided with wheels, on which the machine runs along the ground, until it has attained sufficient speed to enable gravity to be overcome. This peculiarity has earned such machines the nickname of "Grasshoppers." In some cases specially prepared tracks have been provided for this method of starting.

Until the science has arrived at a stage where machines can with ease rise from the ground, it would seem to be more reasonable to provide stations at a height. Rising from rest is the most difficult evolution that an aeroplane can be asked to perform; it would seem to be more reasonable to expect a start to be made from somewhere in its own element. A steamship is not asked to pick up passengers at their front doors.

Perhaps the assistance of vertical helices will be required eventually

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for the raising of the machine from rest on the ground. In such a case the vertical helices might be required to revolve into the horizontal position when sufficient height had been attained.

The pluck of the pioneers of this science is much to be admired, when it is considered that, in most cases, they have carried out their experiments over the hard ground. A more rational method would surely be to experiment over a warm and shallow sea, the machine being provided with a buoy and line, and the operator with a lifebelt, to ensure recovery of both in case of a fall.

Alighting is a point which has apparently been little considered. The "grasshoppers" alight on their wheels and run along the ground until momentum vanishes. The weight of the wheels and their gear must cause a certain amount of power to be wasted. Vertical helices may eventually solve the question.

If aerial stations are adopted, they would have to be so designed as to be able to catch the machine after a flight, as well as to start it on a flight. In the case of alighting, if the operator brings his machine up with too much weigh on, or misses the landing station, then he has plenty of room to get weigh on again and try a second time. Not so on the ground. In this case a bad shot means a broken machine and great danger to the operator.

It seems probable that bringing an aeroplane to its moorings will be an exceedingly difficult evolution. The machine will have clearly either to stop almost dead and drop down on to a cradle, or will have to hook on, below a horizontal arm, when travelling at its lowest speed. Neither of these operations appears to be easy of accomplishment.

A perfect type of aeroplane should be able, in case of an accident to the machinery or propellers, to glide gently to the ground without receiving damage. This quality is not yet in sight.

To sum up. If perfect automatic equilibrium, both lateral and longitudinal, as well as a fair percentage of efficiency in the propeller could be attained, there does not seem to be any reason why aeroplanes should not become a practical proposition, but as these points have as yet baffled human genius it may not be correct to be too sanguine.

Aeroplanes will probably never become commercially possible and will never compete with the present methods of transport, but for private, sporting, and similar purposes, they will naturally be in great request.

In warfare they will be invaluable for scouting, if, indeed, it will be possible to make accurate observations when travelling at high speeds. It seems exceedingly doubtful if the power of demolishing battleships by dropping explosives, which is given to aeroplanes by novelists and other visionaries, will be within the range of practical politics. It is at any rate not in sight at present.

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THE FORTIFICATION SCHOOL AT THE S.M.E.

By Lieut.-Colonel B. R. Ward, R.E.

On October the 28th, 1812, Major Pasley issued his first order as "Director of the Royal Engineer Establishment." It runs as follows :—

"By virtue of His Royal Highness the Prince Regent's warrant issued in the name and on behalf of His Majesty, bearing date the 23rd April, 1812, whereby he was pleased to authorize an Establishment for the Instruction of the Corps of R.M. Artificers, or Sappers and Miners, and of the Junior Officers of the Corps of Royal Engineers, in Military Field Works, of which Major Pasley has been appointed Director, the N.C. Officers and Privates of the Detachment who are, or may hereafter, be employed in learning the practical part of the Field Duties, shall be classed as follows :—All N.C. Officers not qualified to act as Assistant Teachers, shall be put upon the First Class allowance immediately on joining this Establishment, but the Privates shall be put upon the Second Class until a sufficient period shall have elapsed to enable the Officers to judge of their merit, after which, those who are recommended as the most deserving men, shall be placed on the First Class. Drummers not grown up shall be placed on the Third Class, as shall be placed such Privates as are negligent or inattentive to their Field Duties, or who are guilty of unsoldierlike conduct and irregularities. . . . The allowance for the three Classes are as follows :—The 1st Class, 9d. per diem ; the 2nd Class, 6d. per diem ; and the 3rd Class, 3d. per diem.

"The temporary Field Works which will be constructed here merely serve for the Instruction of the men, so that after one set of men has been trained, the works erected by them will be pulled to pieces and the ground levelled, in order that new works may be constructed for the instruction of another Party. As these works will, therefore, not be of any permanent use or benefit to the Country, like the works which the men will be employed in constructing in Garrisons, the allowances granted to men employed in this Establishment must be considered very liberal on the part of the Government.

"It is intended that the whole Corps of R.M. Artificers, or Sappers and Miners, shall go through the same course of duty at present performed by the detachment here, receiving the above-mentioned allowances, until they have learned their Field Duties, and everyone knows that in all trades and professions, a learner or apprentice

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cannot expect the same wages as he might claim when perfect in it. But at all other times when employed in work they will receive the regular working pay specified in His Majesty's warrant for the formation of the Corps with which the present warrant does not interfere, the Duties being perfectly distinct, etc., etc., etc.

"The men will parade for drill at 7.0 a.m., 10.30 a.m., and 2.0 p.m. The new detachment will commence Practical Geometry, Arithmetic, etc., to-morrow morning, and those who attend these duties shall be exempt from the morning drill. Those who are reported perfect in drill will commence Field Works on Monday morning."*

Thus was the School started, and the first company of trained sappers to be sent out to the Peninsula was despatched with a division of battering train ordnance from Portsmouth in the following July.

The fleet of transports arrived off San Sebastian on the 19th August, 1813,† and a company of sappers was landed on the following day. This company (the second of the 2nd Battalion) was the first company in the Corps to wear the scarlet uniform. They were nicknamed "Pasley's Cadets"‡ by their old-fashioned, blue-coated comrades.

Sir John Jones has testified to the fact that Pasley's cadets were "useful and intelligent"; and, although they had not much opportunity of distinguishing themselves during the short remaining period of the Peninsular War, it may fairly be claimed that the R.E. Establishment, as a Fortification School, had proved its value, even before the experience of the Waterloo Campaign had established its reputation beyond the possibility of cavil.

The original Royal Warrant of the 23rd April, 1812, authorizing the Establishment at Chatham, distinctly laid down that the sole object of that Establishment was the instruction of the Corps of Royal Sappers and Miners, and of the junior officers of the Corps of Royal Engineers, in military fieldworks.

The Fortification School is now only one of the branches of the S.M.E., but in 1812 the R.E. Establishment was a Fieldworks School and nothing more. At first the instruction of officers appears to have been entirely theoretical.§ The staff of the R.E. Establishment was no doubt at first kept down at too small a number to admit of officers being told off in instructional classes.

The following extract from p. 10 of the *Standing Orders* published in 1818, shows, however, that officers were, to some extent at least, expected to look after their own technical education :—

"Officers of the Royal Engineers are always to consider themselves

* Porter's *History of the Corps*, Vol. II., pp. 172 and 173.

† Jones' *Sieges in Spain*, 3rd edition, 1846, Vol. II., p. 51.

‡ Connolly's *History of the Royal Sappers and Miners*, 2nd edition, 1857, p. 202.

§ Pasley's *Standing Orders*, p. 217.

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on duty. If they are not ordered for practical duties, they will be employed in drawing plans, writing useful memoirs, etc., and even if no positive task of this nature should be assigned to them by their Commanding Officer, they ought to feel so much the importance of their situation, and the character they have to support in the Army, that they ought voluntarily to occupy themselves in the study of their profession, and of military affairs in general."

The N.C.O.'s and men were, however, on a different footing. Every non-commissioned officer, private, and bugler, doing duty at the Establishment, had to attend the regimental schools every morning, either as a teacher or learner.

The chief object of the course of study in these regimental schools was—as laid down by Pasley on page 129 of his *Standing Orders* of 1818—"to qualify the non-commissioned officers and privates for the very important duty, which continually falls to their lot on service, of assisting their officers to lay out fieldworks, etc., and to superintend the execution of them, by giving such directions as may be necessary to working parties, furnished either by regiments of the line, or by peasants of the country which is the seat of war."

Many men of the Royal Sappers and Miners, however, could neither read nor write. These had to pass successively through the reading and writing schools before attending the School of Practical Geometry. This last school was conducted as laid down in the first volume of Pasley's *Course of Military Instruction.*

Having been taught the principles of plan drawing, they went on to the second volume of the *Course of Military Instruction,* which included Fortification and Military Mining. Arithmetic and mensuration were next taught, with special reference to fortification, the men being taught, for instance, how to calculate the number of cubic yards of excavation in a given length of parallel of a given profile. Meanwhile practical work in the field was being carried out concurrently with the work in the regimental schools. The men were also taken to some convenient part of the Lines, or to Fort Pitt, and the terms of permanent fortification as exemplified in the bastion trace were explained to them.

Pasley was very particular as regards correct nomenclature and pronunciation. At the various *vivâ voce* examinations, on which Pasley laid great stress, the officers and N.C.O.'s on duty were held responsible that the terms laid down in the printed *Course of Instruction,* and in the manuscript *Memoirs of the Establishment,* were invariably adhered to, "without any mixture of French or other foreign phrases";* and, as regards pronunciation, "the barbarous terms, *gabeen,* instead of *gabion, fasheen,* etc., borrowed from the old artificers," were to be checked by the officers.†

* *Standing Orders,* 1818, p. 158.
† " " " p. 135*n*.

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The course of instruction for officers in Pasley's time is laid down in Section XV. of the *Standing Orders* of 1818. It consisted in drawing a couple of plans referring to the attack of a regular fortress, in writing a series of memoirs on brushwood, bridges, saps, mining, pontooning, etc., and in framing estimates of men, horses, and stores for completing an engineer brigade, a train of 20 pontoons, and a bridge equipage of casks.

As the officers under instruction were employed in superintending all the practical duties carried out at the R.E. Establishment, and were also entrusted with the monthly examination of the men of the companies to which they were attached, it was expected that they would be able to pick up sufficient information in field engineering subjects to enable them to tackle the foregoing plans, memoirs, and estimates. In addition to this, manuscript memoirs and other documents belonging to the R.E. Establishment were kept by the Clerk of Works, and were available for their assistance.

A progress return of the junior officers at the Establishment was forwarded every month to the Inspector-General of Fortifications. This return showed the number of plans and memoirs completed by each officer under instruction.

During the Directorship of Sir Frederic Smith—Pasley's successor in 1842—translations from the French official journals of sieges in the Peninsula were added to the officers' course. Some 50 volumes of these journals—the journal of each siege being bound up separately—are still in existence among the S.M.E. archives. In order to ensure continuous work, the original and translation had to be sent in until completed to the adjutant's office every Sunday morning at 9 o'clock.

This practice of translating Belmas' *Journaux des Sièges dans la Péninsule de 1807 à 1814* was continued during the Directorship of Sir Harry Jones, and appears to have been dropped soon after the Crimean War, during the Directorship of Colonel H. Sandham.

The course of instruction for the N.C.O.'s and men of the Royal Sappers and Miners is laid down in Section XIII. of the *Standing Orders* of 1818. Instruction in fieldworks, or, as it is called in the *Standing Orders*, in the "practical operations," was carried out throughout the year. Mining, for instance, was considered a suitable occupation for the winter months, pontooning being generally carried out in summer time.

A progress return for the companies of Royal Sappers and Miners, serving at the R.E. Establishment, was sent monthly to the Inspector-General of Fortifications, and in this return the N.C.O.'s and men were classified under the various branches of instruction as "Able," "Imperfect," or "Unpractised."

One company at the Establishment was looked upon as a depôt company. This company furnished N.C.O.'s to act as teachers in the regimental schools, and also furnished men for the duties of the

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workshops, and for modelling when required. Transfers occasionally took place between the depôt company and others, so as to bring in new N.C.O.'s and men as instructors from time to time.

Since the establishment of the Fortification School at Chatham siege manœuvres on an extensive scale have been carried out on several occasions.

The earliest of these—so far as any record can now be traced—took place in 1833. A drawing made by Capt. J. Jebb, R.E.—afterwards Sir Joshua Jebb—was lithographed at the R.E. Establishment, and represents the trenches occupied by the garrison, and the explosion of a mine that took place on the 18th June, 1833. A copy of this lithographed drawing is now hanging in the Museum in the R.E. Institute. This picture is of considerable interest, as it represents perhaps the earliest manœuvres, properly so-called, that ever took place in this country. Field manœuvres were certainly not instituted until after the Crimean War, and were in any case very slightly developed until after the Franco-German War of 1870.

Siege manœuvres were however carried out at the R.E. Establishment in 1833, when Colonel Pasley was Director, and again in 1844, 1846, and 1848, under the Directorship of Colonel Sir Frederic Smith. Lithographed accounts of the operations in the forties are extant in the S.M.E. archives. The siege operations from 1833 to 1848 were directed against the left flank of the inner Chatham Defences, from Prince Frederic's Bastion to the Terrace Bastion. This front of attack included the old ravelin—still standing—between Prince Frederic's Bastion—now occupied by the S.M.E. workshops—and the Duke of Cumberland's Bastion. The right face of the latter bastion is still quite distinguishable, overlooking as it does the space between the officers' block and Block B of the new Naval Barracks. The salient of the bastion has been cut away to form the slope down to the Naval Barracks.

The bastioned fronts attacked—Prince Frederic's and the Duke of Cumberland's Bastions—are alluded to in the account of the operations lithographed in 1848 as "old fieldworks." They probably formed part of the early defences of Chatham before the permanent works known as the Great Lines were constructed. The latter were completed about 1807, having been commenced in 1758.

During the fifties no siege manœuvres appear to have been carried out. Doubtless the Siege of Sebastopol gave sufficient experience and practice in this class of work to render peace manœuvres a work of supererogation. A new edition of Pasley's *Instructions on Mining* was, however, got out by Capt. H. St. George Ord, Adjutant, Royal Sappers and Miners, in 1853, during the Directorship of Sir Harry Jones.

It was not until 1868—during the Directorship of Major-General Sir Lintorn Simmons—that the next siege manœuvres took place.

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These manœuvres consisted entirely of mining operations, the attack being carried out against the salient of the right demi-bastion in front of St. Mary's Casemates.

It is interesting to note that the junior officer employed in the attack was H.R.H. Prince Arthur, who at that time held a commission in the R.E., prior to his transfer to the Rifle Brigade. Thirty-nine years later the same Royal Prince, as Inspector-General of the Forces, attended the siege operations that were carried out against two of the Chatham detached forts in August, 1907.

In 1871, when Colonel Thomas Gallwey was Commandant of the School of Military Engineering, siege manœuvres were carried out against the left of the Great Lines. An account of these operations is given in the *R.E. Journal* for November, 1871.

In 1873 siege operations took place against the same portion of Lines, mining operations being conducted against the New Ravelin, an earthwork which had been thrown up by convict labour in the previous year. An account of the operations is given in the *R.E. Journal* for July and August, 1873.

Again in 1877 mining operations were conducted against the New Ravelin. On 27th July, 1877, an assault, in which all the troops of the garrison took part, was carried out. An account of the operations, which were conducted under the eye of H.R.H. the Duke of Cambridge, is given in the *R.E. Journal* for August, 1877.

From 1877 to 1907—a period of 30 years—no real siege manœuvres appear to have been carried out at Chatham. Possibly the experience of the war of 1870 encouraged the view that fortresses could be taken by blockade. Plevna, in 1876, was more of an attack on a field position than a regular siege, and it was not till the Siege of Port Arthur in 1904 showed the possibilities of close fighting at sieges under modern conditions, that the almost forgotten art of siege warfare was again studied.

The siege manœuvres of 1907 are so recent that nothing further need be said about them, except that they were carried out on a more extensive scale, and have been more elaborately recorded than any previous siege manœuvres carried out in this country.

Bridging manœuvres have been carried out over the Medway on various occasions. When Colonel Leahy was Instructor in Fieldworks (1871–1876) a pontoon bridge was thrown across the Medway at Upnor. The infantry of the garrison and a field battery were marched over the bridge. Later, in August, 1877, similar manœuvres were held at Wouldham, and in 1898 again at Upnor.

A scheme is being prepared for similar manœuvres to be carried out during the present year at Upnor.

The following are a few of the fortification text books which have been got out at the S.M.E. since Pasley's first *Standing Orders*, in 1818 :—

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Rules for Conducting the Practical Operations of a Siege, by Lieut.-Colonel C. W. Pasley, R.E., F.R.S., 1829.

Rules for Sapping, issued by Colonel H. D. Jones, 1854.

Batteries, etc., in Accordance with the Field Instruction at the R.E. Establishment, by Major F. C. Hassard, 1858.

The Sapper's Manual, by Capt. W. A. Frankland, 1868. This appears to have been the original form of the *Manual of Military Engineering*, the present engineering text book for officers of all arms.

Shortly afterwards, a single bulky volume, entitled *Instruction in Military Engineering*, was got out, and in 1872 the first edition of the present series, in six parts, of field engineering text books was published under the same title. The title has recently been altered to *Military Engineering*. These text books are constantly under revision.

The present course for officers lasts for 105 days, the sapper recruits' course lasting 71 days. Sappers destined for Fortress (Electric Light) Companies go through a shortened course of 56 days.

In May and August in each year courses for officers of the Territorial Force are carried out. A course for the rank and file of the Territorial Force is also conducted in August.

A course for cavalry pioneers—officers and men—is carried out in October.

A Qr.-Mr.-Sergt. Instructor is sent for two months every year to the Cavalry School at Netheravon to instruct officers and men in fieldworks, and similarly Qr.-Mr.-Sergt. Instructors are sent to the Anglesey and Monmouth Militia—now Territorial Force.

An annual refreshing class is held for N.C.O.'s of R.E. service units. This course lasts 40 days. N.C.O.'s destined for duty on the Permanent Staff of R.E. Territorial units go through a course of 60 days' fieldworks. R.E. N.C.O.'s selected for service in India go through a six weeks' course at the Fortification School. A 12 days' course for infantry pioneer sergeants is also held annually.

In addition to all this instructional work, the Fortification School is kept busily employed in experimental work. For instance, a new bridge equipment for field troops, mining tools, and stores for demolitions, have all recently been taken in hand. This work is carried out under the direction of the R.E. Committee.

Medals are given to junior officers under instruction, and to recruits, for proficiency in fieldworks. These medals are provided from a fund forming the balance of subscriptions raised to commemorate the late Capt. Alfred E. Haynes, R.E. A short obituary notice of this officer was published by Sir Charles Warren in the *R.E. Journal* of the 1st September, 1896.

Capt. Haynes obtained his first commission in 1880, and was killed in action in East Africa in 1896. He had done good service as a subaltern in 1882 under Colonel Warren in the Desert of Sinai.

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Twelve years later Haynes published an account of this expedition—which was undertaken in order to bring to justice the murderers of Palmer and Gill—in a book entitled *Manhunting in the Desert*, published in 1894. He was again employed in 1884 under Colonel Warren, who, in organizing the Bechuanaland Expedition, selected Haynes as his private secretary. For his services in this capacity he was mentioned in despatches.

Haynes' connection with the S.M.E. extended over a period of several years. From 1890 to 1895 he was employed under Major A. O. Green as Assistant Instructor in Survey. In 1895 and 1896 he was in command of A Company. This duty he carried out so well that he was informed, on leaving the S.M.E., that probably the most useful period of his career had been the year in which he was employed on the duty of commanding a company of the Training Battalion.

In May, 1896, he sailed for Mauritius in command of the 43rd Company, which had just been raised. He reached Durban with his company in the *Garth Castle* at the end of June. Affairs were at that time in a critical condition in Mashonaland. Haynes telegraphed to the G.O.C., Cape Town, for permission to join the force then being organized under Colonel Alderson. The offer was at once accepted. Haynes and his party of 3 officers and 91 rank and file did good service on the expedition, and he himself was killed—shot through the head—while leading an assaulting party which captured Makoni's stronghold on the 3rd August, 1896. A memorial tablet to Capt. Haynes has been erected in the South Transept of Rochester Cathedral.

The first award of Haynes Memorial Medals was made in 1902. A bronze medal is given to the officer in each batch of young officers after going through the course of fieldworks, the nomination being made by the Commandant, S.M.E.

The following officers have been awarded the medal up to date :—

1902.—2nd Lieut. E. W. Cox.
" S. W. S. Hamilton.
" C. W. Bushell.
1903.— " A. H. L. Mount.
1904.— " C. R. Satterthwaite.
" E. V. Binney.
1905.— " L. C. B. Deed.
" L. E. Becher.
1906.— " J. A. A. Pickard.
" E. M. Sinauer.
1907.—Lieut. R. Hamilton.
2nd Lieut. H. L. Woodhouse.

A bronze medal is also given to the sapper in each batch of recruits who is best qualified in fieldworks after going through the recruits'

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course in that subject, the nomination being made by the Officer Commanding Training Battalion.

The following sappers have been awarded the medal up to date :—

Regl. No.	Name.	No. of Squad or Party.	Year.
9322	C. R. Duhy.	(51)	1902
1838	P. Harcourt.	(52)	,,
9482	F. Deeks.	(53)	,,
9689	A. Watkins.	(54)	,,
9936	G. Gurnsey.	(55)	,,
9983	J. H. Howard.	(56)	,,
6849	F. Millar.	(57)	,,
10445	S. F. Poole.	(58)	,,
10458	J. McWilliams.	(59)	,,
10565	W. Andrew.	(60)	,,
10453	W. Betts.	(61)	,,
2396	W. R. Cullen.	(62)	,,
11062	G. H. Webber.	(63)	,,
11119	E. G. Lehern.	(64)	1903
11261	A. E. Drew.	(65)	,,
11362	J. Hanna.	(66)	,,
11409	W. J. Edwardes.	(67)	,,
11459	J. Hurst.	(68)	,,
11747	F. J. Padfield.	(69)	,,
11870	E. Mahoney.	(70)	,,
11905	C. Stevens.	(71)	,,
12004	F. A. Robson.	(72)	,,
12095	L. Lloyd.	(73)	,,
4458	N. Wall.	(74)	,,
12717	H. Gibbons.	(76)	1904
12738	A. J. Alabaster.	(77)	,,
12511	T. Wilson.	(75)	,,
12750	J. Mealy.	(78)	,,
12673	E. Pickford.	(79)	,,
12836	T. H. E. Wood.	(80)	,,
12859	F. Ridd.	(81)	,,
12910	A. Mackercher.	(82)	,,
12940	J. Tanner.	(83)	,,
12967	E. W. Hoyton.	(84)	,,
13139	W. J. Ruse.	(85)	,,
13250	H. Hearn.	(86)	,,
13393	A. R. Lidstone.	(87)	,,
13576	G. R. Smith.	(88)	,,
13755	H. Seviour.	(89)	1905
13771	S. H. Wass.	(90)	,,
14081	S. Woods.	(92)	,,
10523	A. Humphreys.	(91)	,,

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Regtl. No.	Name.	No. of Squad or Party.	Year.
14335	J. Ward.	(93)	1905 (*cont.*)
14341	G. E. Balfe.	(94)	,,
13656	G. Glover.	(95)	,,
14572	W. J. Hadley.	(96)	1906
14610	S. H. Oborne.	(97)	,,
14707	C. H. Milne.	(98)	,,
10100	W. W. Parsons.	(99)	,,
14806	G. Beatty.	(100)	,,
10153	T. Deveney.	(101)	,,
15064	B. Hobdey.	(102)	,,
11244	J. E. Hughes.	(104)	,,
15140	A. H. Godfrey.	(103)	,,
15423	A. A. Irwin.	(105)	,,
15665	W. Wilson.	(106)	,,
15710	G. Alesbury.	(107)	1907
15868	A. R. Box.	(108)	,,
16054	H. M. Mace.	(109)	,,
15249	E. Smith.	(110)	,,
16481	J. Gardner.	(111)	,,
13735	J. W. Barnett.	(112)	,,
16275	H. Goodfellow.	(113)	,,
16641	O. W. Ennever.	(114)	1908
4519	H. Gunning.	(115)	,,
16760	R. Shirley.	(116)	,,

The following is a complete list, as far as can now be ascertained, of the various officers who have held the appointments of Instructor and Assistant Instructor in this branch of study.

During the early years of the R.E. Establishment, the instruction was no doubt mainly carried out by the Director and the Adjutant.

INSTRUCTORS IN FIELDWORKS.

Adjutants up to...	1841-
2nd Capt. J. W. Gordon	1846-
Major Hassard	1855-1859
,, J. W. Lovell	1859-1865
Brevet Colonel W. O. Lennox, V.C. ...	1865-1871
Brevet Lieut.-Colonel A. Leahy ...	1871-1876
Lieut.-Colonel J. P. Maquay	1876-1879
Major A. G. Durnford	1879-1883
,, M. T. Sale, C.M.G.	1883-1887
,, J. W. Savage	1887-1891
,, T. R. Main	1891-1896
,, L. C. Jackson	1896-1902
,, G. M. Heath, D.S.O.	1902-1906
Brevet Lieut.-Colonel G. H. Fowke ...	1906-

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ASSISTANT INSTRUCTORS IN FIELDWORKS.

Lieut. G. Phillips	1855-1858
„ A. W. Durnford	1858-
„ C. G. Gordon	1859-
„ V. G. Clayton	1859-1860
„ J. M. H. Maitland	1861-1862
„ V. G. Clayton	1862-1866
„ J. J. Robertson	1866-1867
„ T. Fraser	1868-1873
Capt. W. Merriman	1871-1875
„ R. H. Williams	1873-
„ M. T. Sale	1873-1876
Lieut. S. Waller	1876-1878
Capt. J. Matheson	1875-1881
Lieut. M. H. Gregson	1879-1883
„ T. R. Main	1881-1887
„ H. N. Smith	1883-1884
Capt. H. W. Renny-Tailyour	1884-1886
Lieut. G. E. Shute	1884-1889
Capt. H. J. W. Jerome...	1887-1888
Lieut. A. W. Roper	1888-1892
Capt. W. M. Hodder	1889-1891
Lieut. J. R. Young	1891-1896
„ E. McL. Blair	1892-1896
„ J. C. Matheson	1896-1902
„ E. D. Swinton (S.A. 1899-1902)	1896-1902
„ R. L. B. Thompson	1901-1904
„ C. B. Thomson	1902-1905
„ R. L. Waller	1904-1908
„ A. H. du Boulay	1905-

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MEMOIRS.

LIEUT.-GENERAL JAMES JOHN MCLEOD INNES, V.C., C.B.

LIEUT.-GENERAL JAMES JOHN MCLEOD INNES, V.C., C.B., who died in last December, was born on the 5th February, 1830, and was the son of James Innes, Esq., Surgeon, Bengal Army. He joined the H.E.I. Company's Military College at Addiscombe in February, 1847, and passed out at the head of his term, and with the Pollock Medal, in December, 1848. He was the second cadet to receive the Pollock Medal, the first recipient being the late General Sir Edward Sparshot Williams, R.E., Colonel Commandant, Royal (Bengal) Engineers, whose death in October last only preceded that of General Innes by two months.

Lieut. Innes arrived in India in November, 1850, and was employed in the P.W.D. on the construction of the Baree Doab Canal, in the Punjab; but, on the annexation of Oude, he was transferred as Assistant to the Chief Engineer in that Province, and consequently served throughout the Mutiny Campaign, in Oude, from May, 1857, to April, 1858.

At the outbreak of the Mutiny he was placed in charge of the Muchee Bhowan at Lucknow, with orders to fortify it so that it might serve as a place of refuge.

After the action at Chinhut, the post had to be evacuated and the whole force concentrated at the Residency. The troops were successfully withdrawn, and the fort blown up under the direction of McLeod Innes. He served throughout the defence of the Residency, and was especially distinguished in the direction of the mining operations. One of the defences was known as Innes's post, and it was unsuccessfully attacked by the enemy on several occasions. On the relief of Lucknow by Havelock, McLeod Innes took part in several sorties, and was then placed in charge of the mining operations in the new position occupied by the relieving force.

Early on the morning of July 20th, 1857, the officer on the look-out tower of the Residency reported that the enemy was moving in large masses, and was evidently assembling for a vigorous attack. Every man was at his post, when suddenly a mine was exploded by the enemy in the direction of the Redan Battery, leaving an enormous crater. Innes's post bore the brunt of the attack. The enemy

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advanced boldly, leaving a scaling ladder in the ditch, but were repulsed and driven off by hand grenades.

As an instance of the heavy fire brought to bear on the position in September, shortly before Havelock's relief, may be mentioned the cutting down of the upper story of a brick building by musketry fire only. This building was in a most exposed position just behind the Cawnpore Battery. All the shots which just missed the top of the rampart cut into a dead wall almost in a straight line, and at length cut right through and brought the upper story tumbling down. The upper structure on the top of the Brigade Mess also fell in. The Residency house was a wreck. Capt. Anderson's post had long been knocked down, and Innes's post also fell in. These two were the most exposed positions in the garrison, and were riddled with round shot. The effect of the rains, too, was to bring down all the shaky buildings to the ground, leaving the defenders only some shattered defences to cling to. The mining was continuously persevered in; defensive mines were resorted to, and were exploded in several directions, thus destroying the enemy's underground approaches.

After the relief by General Havelock the defence was chiefly confined to mining and countermining operations. General Outram wrote on the subject in his despatch dated November 25th :—

"I am aware of no parallel to our system of mines in modern war. Twenty-one shafts, aggregating 200 feet in depth, and 3,291 feet of gallery have been executed. The enemy advanced 20 mines against the palaces and outposts; of these they exploded three, which cost us loss of life, and two which did no injury; seven have been blown in, and out of seven others the enemy have been driven, and their galleries taken possession of by our miners, results of which the Engineer Department may well be proud."

In March, 1858, Lieut. Innes was attached to the Jownpore Field Force, under Brigadier-General Franks. This force joined the army under Sir Colin Campbell before Lucknow on March 5th, after a march of 150 miles. Whilst with it Lieut. Innes performed an act of gallantry for which he received the V.C. The incident is thus narrated by General Franks :— "I have already mentioned his distinguished conduct in the attack on Dhowrara" (he had been severely wounded whilst endeavouring to burst open the door of a house, within which some mutineers had barricaded themselves). "It is now his due to relate that at the action of Sultanpore, far in advance of the leading skirmishers, he was the first to secure a gun which the enemy was abandoning. Retiring from this, they rallied round another gun further back, from which the shot would in another instant have played through our advancing columns, when Lieut. Innes rode up, unsupported, shot the gunner about to apply the match, and remained undaunted at his post, the mark for a hundred matchlockmen sheltered in some adjoining huts, and kept the

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artillerymen at bay until assistance reached him. For this act of gallantry, surpassed by none within my experience, it is my intention to recommend him for the honourable distinction of the V.C."

When Addiscombe was finally done away with on 7th June, 1861, Sir Charles Wood—who was Secretary of State for India—presided at the last examination and delivered an address on the breaking up of the College. He drew attention to the success of the establishment, which was to be found in the number of distinguished officers who had been trained within its walls, and proceeded in his address as follows:—

"Without going back to the more recent times, I may refer to the severe trials which fell upon our Indian Empire by the Mutiny of 1857, and on that occasion those who were the most remarkable for their exertions, gallantry, bravery, and skill were those distinguished officers who were trained within the walls of Addiscombe College. I hardly know whether I should be justified in naming particular persons, as it might appear invidious, when all have behaved so well, to select them; but I will venture to speak of Sir Henry Lawrence, Sir Robert Napier, Sir Archdale Wilson, to whom Delhi fell, and other officers whom I would willingly name; but I am afraid, if I were to do so, it might appear that I had selected them with less discrimination than I should like to show on the present occasion. In every branch of the Service the warmest testimony has been given by the Authorities of India to the gallant conduct of the gentlemen educated in this College. Recently Lord Canning, in conferring the V.C. on one of the Engineer officers, spoke of him in the highest and warmest terms, for, whether in civil or military engineering, Addiscombe has never been excelled, and I may say that the skill with which the sieges have been conducted by the Engineers of India exceeded that of any other country in the world."

The Engineer officer referred to by Sir Charles Wood was Major McLeod Innes, and it may not be inappropriate to quote the words used by the Viceroy when presenting the Victoria Cross in 1858. Lord Canning said: "I must add that it is a peculiar pleasure to me to present this cross to an officer of the Bengal Engineers, for I say to you—not as a compliment, but in the words of sober truth—that I do not believe that there has ever existed, in any army, a body of men who have rendered, individually and collectively, more constant and valuable services to their country than the Engineers of Her Majesty's Indian Forces. Men, all of them of proved ability and highly cultivated intellect, they have been unceasingly called upon in peace, as much as in war, to achieve great tasks for the protection and advancement of India, and they have never been found wanting. That, when summoned to meet an enemy in the field, they can carry their lives in their hands as lightly as any man your own deeds, and those of many of your brother

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officers, have abundantly proved. It is in itself a distinction to belong to such a Corps, and you, Major Innes, have the proud satisfaction to know that while you have derived honour from being enrolled among the Engineers of the Army of Bengal, you have done all that a gallant soldier can do to repay that honour in augmenting, by your own acts, the lustre and reputation of your distinguished regiment."

After the conclusion of the Mutiny Campaign, Major Innes was appointed Garrison Engineer of Fort William, and served in various grades in the P.W.D. in the Central Provinces and Punjab until 1867.

In 1868 he was employed on the Commission for investigating the failure of the Bank of Bombay; and in 1869 he started the upper section of the Indus Valley Railway. In 1870 he was appointed Accountant-General of the P.W.D., and held this important post for 10 years. In 1881 he was appointed Inspector-General of Military Works, and as such drew up designs for coast and frontier defences, and carried out most of the new internal defences.

He received a Brevet Majority on the 28th August, 1858, attained the rank of Major-General, 28th November, 1885, and retired in March, 1886, as a Lieutenant-General.

In the *Gazette* of June, 1907, he was made a C.B.

After his retirement General Innes devoted himself to literature, and published, among other works, *Lucknow and Oudh in the Mutiny; The Sepoy Revolt, 1857; Sir Henry Lawrence* (Rulers of India Series), 1898; *Life of Sir James Browne, K.C.S.I., R.E.*

General McLeod Innes suffered from severe illness during the latter years of his life. He was married in 1855 to the daughter of Prof. Hugh Macpherson, of Aberdeen, and died on the 13th December, 1907.

I am indebted to Colonel H. M. Vibart, R.E. for many of the above details, which have been derived from his excellent book, *Addiscombe: Its Heroes and Men of Note.*

EDWARD T. THACKERAY.

COLONEL HENRY FRANCIS BLAIR.

ON the 13th April, in his 72nd year, there died, in his house in Paddington, Colonel Henry Francis Blair—the fifth of the old Corps of Bengal Engineers who has passed away in the last year. He was a native of Lunan, Forfarshire, and came of a fighting race. His father, Brigadier-General Blair, an old Company's officer for 40 years, served with distinction in India, commanding the Nizam's Cavalry from 1835 to 1847.

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Blair and I entered Addiscombe on the same day, the 1st August, 1854, and from an alleged partiality to suet pudding he was immediately known as Dough (pronounced Duff) Blair. Afterwards, in the Punjab, he was always Toony Blair. He was by no means an exemplary cadet. His rollicking high spirits got him into occasional scrapes, and he lost his corporal's epaulettes after an uproarious, but illegal, midnight supper. But a more popular cadet there did not exist; and so it was in after life. His cheery, genial manners, his kindly heart, and his big, manly personality, made friends for him everywhere.

After the ordinary two years' course at Addiscombe, Blair and I received our commissions in the Bengal Engineers, and went for 18 months to Chatham, going to India early in 1858, just in time for the last Mutiny campaign. For the rest of our service we saw very little of each other. He was posted to the Public Works Department in the Punjab. I was an Irrigation man in what is now called the United Provinces of Agra and Oudh. But from time to time amusing stories used to find their way down country of Blair's energy and independent way of doing work.

These were active days in the Punjab, and Blair and his bosom friend, "Buster" Browne, working under a beloved Chief Engineer, General Sir Alexander Taylor, have left their mark behind them in many miles of good roads, in bridges, and in Government buildings, including churches at six frontier stations. I believe he was the first to employ British soldiers in making hill roads during the hot months that they would otherwise have been spending in hot plains stations.

There was a famous story—and a true one—of timber being urgently required to roof some barracks, and of Blair's starting off to the deodar forests of Kharghan, and personally conducting a string of rafts 200 miles down the River Jhelum in flood, he himself riding a water skin.

But all this time Blair did not cease to be a soldier. He knew no fear, and his reckless courage and self-exposure, called forth on him once his General's reproof—who told him that he wanted his services as an engineer, not as a gladiator. He served throughout the Umbeyla campaign, and was present in several hot fights. He served throughout the Afghan campaigns from 1878 to 1880, receiving a medal and clasp, and a brevet lieutenant-colonelcy. He did notable work in keeping the hill roads of communication fit for artillery, due to his rare gift of winning the affection of wild tribesmen, and persuading them to work for him. His plan for floating the sick and wounded in Afghanistan, on rafts down the Kabul River to Dakka, proved a boon to many, and received special thanks.

In 1868 Blair married the daughter of Capt. John Bott, of the Bengal Cavalry, who was killed in the retreat from Kabul in 1842. She survives her husband, with a family of three sons and two daughters.

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Blair retired from the Service in 1883. He settled in Paddington, and in 1886 was elected a member of the Vestry, on which he served continuously until it was transformed, in 1900, into a Borough Council, of which he became an Alderman. Here began a fresh career of usefulness.

A local paper says of him :—"His vigorous nature, sound common sense, and unswerving rectitude, soon gave him a prominent position among his colleagues, whose esteem he enjoyed without distinction of party. He did good work for the ratepayers, and he also, for 17 years, played an active part on the Paddington Board of Guardians. . . . and, though he used very plain language on occasion, even his opponents admired his outspoken frankness, and transparent honesty of character."

For years he also served on the Board of Management of St. Mary's Hospital.

It is easy to imagine what a blow it must have been to one who was an athlete and first-class all-round sportsman when, 17 years ago, he was stricken with blindness. It would have crushed the spirit of most men; but Blair's was not crushed, rather he sought to show how a brave heart could triumph over such drawbacks. Not even in the intimacy of his own family did he ever give way to depression. He made as little change in his life as possible. He traversed London streets alone. He told me, with glee, how once a man on a bicycle ran him down and had his leg broken, and how he put him in a cab and carried him off to a hospital. He did not even give up fly-fishing, and was proud of the skill he retained in catching salmon in the Don, in Aberdeenshire. He was as sunny and cheerful, his temper as sweet and unruffled, as in early days on the Punjab frontier.

For the last few months his health had been failing, but his pluck was indomitable to the end. All must join in feeling deep sympathy with his widow and family in their sorrow.

The crowd that attended his funeral helped to show how much "the blind Colonel" was loved and respected.

COLIN SCOTT-MONCRIEFF.

MAJOR-GENERAL CHARLES NASSAU MARTIN.

MAJOR-GENERAL C. N. MARTIN, of Mount Long Castle, County Cork, Ireland, was born in 1832, and educated in Germany, and afterwards at the Royal Military Academy, Woolwich, where he became senior under officer, and passed, first of his batch, into the Royal Engineers in 1851, with the sword of honour and several prizes. After the usual course of instruction at Chatham, he served in Jersey,

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Guernsey, and Devonport, before going to the Crimea, in September, 1854. He was present at the Battles of Alma and Inkerman (horse killed), and at the siege of Sebastopol, where he was severely wounded in November, 1854.

In a letter to his sister, the late General Sir Gerald Graham, V.C., G.C.B., wrote with reference to his friend Martin :—"Before Sebastopol, November 23rd, 1854.—Since I last wrote an unfortunate accident has occurred, which I feel very deeply, though I trust it will not turn out to be so serious as I first feared. The day before yesterday (while inspecting some work in front of the trenches) poor Martin was shot by one of the Russian outlying riflemen. The ball entered his stomach and entered his groin somewhere, the same ball passing through another officer's clothes* without hurting him. I went over yesterday, a terribly wet day, to see Martin, or at least to hear how he was. On arriving there, however, I found that it was thought better I should not see him, as it would only excite or disturb him. Whilst there the doctors came to search for and, if possible, extract the ball, which they had not been able to find the day before. This time they found it, but could not extract the ball. I am told he bears the pain like a true soldier. Indeed, in every respect Martin is of a very high chivalrous spirit. He is in fact, unconsciously, quite a 'beau ideal' of chivalry, at once the bravest and the gentlest. You will of course think that my sorrow at his misfortune makes me overrate his virtues, but I will give you a few instances. On the day of the Battle of Inkerman I lost sight of him, and afterwards found that he had gone further than I had into the field, and had his horse shot under him. He also was the officer of ours who sketched the chief part of our position, and, disguised as a rifleman, went out with the advanced skirmishers in order to see as much of the ground in front as possible, being a first-rate sketcher. For his extreme courtesy and gentleness ask his equals, or, better still, his inferiors, to whom I never yet heard him address a harsh or unkind word. However, I hope and believe I am not writing his epitaph. The news to-day is that he is getting on very well."

Martin was several times mentioned in despatches, and received the Crimean Medal with three clasps, and the Turkish Medal; also the Order of Knighthood of the Legion of Honour and the Order of the Medjidie. He was recommended for the Victoria Cross, but, owing to its very limited award, he never received it, much to General Graham's vexation, as I have reason to know. On being invalided home from the Crimea, several efforts were made by eminent surgeons, both in England and in France, with the object of removing the bullet embedded in his body, but the extreme danger of the requisite operation prevented its extraction. Throughout his life its presence

* Capt. (afterwards General Sir) M. Biddulph.

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caused him much suffering, especially at times, when he was obliged to use crutches. His fortitude and endurance were wonderful, however, and his natural constitution must have been excellent to have enabled him to live so many years, and to carry on his duties so efficiently. Martin was employed in the London District during 1856–7, and as an Instructor of Fortification at the R.M. College, Sandhurst, in 1858. In the course of that time he, in conjunction with the "famous" General Charles G. Gordon, assisted Sir Harry D. Jones (then Governor of the R.M. College) in compiling the record of the siege operations at Sebastopol.

From 1858 to 1866 Martin was employed on the Ordnance Survey in Scotland, and at Southampton; also in Ireland. After a short ordinary service in Ireland, he became, in 1867, Instructor of Fortification at the R.M.A., Woolwich, until 1875, when he was appointed Instructor of Surveying at the S.M.E., Chatham.

In 1879 he was again employed as head of the branch of the Ordnance Survey at Phœnix Park, Ireland, until his retirement in 1881. After his retirement he lived in London for some years, and for about three years held the post of Registrar of the School of Science and Art at South Kensington. He afterwards resided at Weymouth for the rest of his life. Martin married Miss Horrocks, at Lymington, in 1863. She died some years ago. He had two sons and two daughters; his elder son, Capt. C. F. Martin, Highland Light Infantry, died in 1893; his younger son, Capt. C. R. Martin, and his elder daughter (now the wife of Major H. A. Pratt, R.A.) still survive, but his younger daughter, who had lived with him at Weymouth for many years, died only a few months ago, and her loss was a terrible grief to him.

General E. R. James says: "We were cadets together in 1848–51; we were associated at Chatham, both being inclined to surveying work. I chiefly remember him for his amiable disposition, and for his charming Irish songs. I did not see him after that until 1855, when I landed in the Crimea, but as he was lying wounded and lingering between life and death, I hardly spoke to him. I can only speak of him as a man of the most amiable and lovable disposition, who was universally a favourite; his long-suffering patience under the intense pain caused by his wound was the most remarkable thing I ever remember."

The late General Sir J. W. Gordon, when C.R.E. in the Crimea, in a report, dated Camp before Sebastopol, 25th November, 1854, wrote: "Lieut. Martin signalized himself for ability, zeal, and cheerfulness in the execution of his duties, and while condoling with Capt. Chapman in deploring the loss of Lieut. Martin's services, I have great satisfaction in taking this opportunity of bringing his name favourably to the notice of the Inspector-General of Fortifications."

In Sir Harry D. Jones' final despatch, of 20th September, 1855, he

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says: "Lieut. Martin is named as one of the officers who particularly distinguished themselves."

The late Field Marshal Sir J. F. Burgoyne, in a letter to Colonel Matson, D.A. General, R.E., said: "Lieut. Martin was dangerously wounded last night, at the advanced trench of our Left Attack. He is a great loss, as he is one (among several) who have always been reported on as most gallant, zealous, and energetic."

It was whilst he was Instructor of Fortification at the R.M. College at Sandhurst, that I first had the pleasure of Martin's acquaintance. I afterwards served with him as an Instructor of Fortification at the R.M.A., Woolwich, for several years, and was quartered concurrently with him at Chatham and Dublin, besides being intimate with him in London afterwards, and in fact right up to the time of his death on the 30th March last. It was for the latter reason that General E. R. James (to whom I am indebted for valuable assistance) suggested my writing this memoir, though he himself was a cadet with Martin at the R.M.A., and served with him afterwards in the Crimean War.

In Martin the Corps has lost an old officer of distinction and talent. Many of the senior officers still serving, besides his own contemporaries (now comparatively few), will grieve for the blank left by his death, as he was one of the kindest and most genial of men, with a nature which was never ruffled, and one whose sterling qualities caused him to be loved by all who knew him.

H. F. C. LEWIN.

CAPT. C. E. VICKERS, R.E.

CAPT. CHARLES ERNEST VICKERS was the youngest son of the late Henry Thomas Vickers, barrister-at-law, of the Hermitage, Blackrock, co. Dublin, and nephew of the late Major-General John William Playfair, R.E. Born on February 23rd, 1873, he was at first educated at Mrs. Strangway's School, at St. Stephen's Green, Dublin, where he remained from 1885 till 1887, and at Clifton College. After nearly two years in the classical side of the college he was transferred to the military and engineering branch, where he distinguished himself in mathematics and drawing.

In the summer of 1890 he passed direct from Clifton into the Royal Military Academy, and obtained a commission in the Engineers in July, 1892, passing out top of his term and gaining the Pollock Medal, as well as the prizes for artillery, fortification, chemistry, physics, and freehand drawing.

After the usual two years' course at the S.M.E. Vickers commenced to take up that line of work in which he afterwards specialized, and spent a year at Derby going through a traffic course on the Midland

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Railway. Upon completion of this course he joined the 10th Company at Woolwich, where he spent the next 2½ years, being chiefly employed on railway work in Woolwich Arsenal. In April, 1898, he left England for his first tour of foreign service, and joined the 42nd (Fortress) Company at Malta, where he remained until the end of 1899. During his stay in this station, though there was none of his own special work to be done, Vickers put his whole heart into the division work and other duties which came his way, and also entered keenly into the social life of the place. It was here that the literary turn of which he was possessed first showed itself, for he became a correspondent of the *Daily Malta Chronicle*, and was for some time acrostic editor of that journal. His original and humorous contributions, published under the pseudonym of "Charles V.," were always worth looking for; and in his quiet way Vickers contributed to the gaiety of the station.

In October, 1899, the 42nd Company left Malta for South Africa, and he went out with it, though, once landed, he did not remain with the unit for very long. There was a great demand for officers with railway experience on the railways, and Vickers was very soon placed on the technical staff as Traffic Superintendent of the Midland Field Section round Naauwpoort, Cape Colony. He held this post at Naauwpoort, Rensburg, Colesberg, and other places during the strenuous times of General French's operations round Colesberg, and finally moved up to Bloemfontein. When the army advanced from Bloemfontein Vickers became Railhead Traffic Officer, which most arduous post he held right away till Kaapmuiden was reached. He was then employed in various capacities in the traffic department of the railways until he was appointed Deputy-Assistant Director of Railways in October, 1901. He continued to hold this post till after the end of the war in July, 1902, when he was transferred for duties under the Commissioner of Railways. After three years in South Africa, during which he had performed most valuable services in that branch of an Engineer officer's duty in which he had specialized, he returned home in November, 1902.

After a short period at Salisbury Plain he was attached for duty at Headquarters in the Office of the Inspector-General of Fortifications, and was appointed Staff Captain at Headquarters in April, 1905. At the time of his death he was under orders to proceed to Gibraltar at the expiration of this appointment.

Vickers—who a short time previously had become engaged to be married—was attacked in January of this year by influenza, and with his usual zeal continued to try and carry on his duties when perhaps he should have been in bed. When he was at last forced to go upon the sick list complications set in, and he died after an operation on February 6th. He was laid to rest with full military honours beside his parents in Mount Jerome Cemetery, Dublin.

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Besides his great devotion to his work he had other and outside interests. He was extremely musical and artistic; was a neat pen-and-ink draughtsman, and had done a considerable amount of etching on copper, some of his prints being exhibited. His literary tastes, which have already been alluded to, found more extended scope during his tour of duty in London, and many original articles from his pen appeared in different periodicals. His last finished effort in this direction—a story of war—appeared in *Blackwood's Magazine* only the month before his death, under the pseudonym of "105." He was also a constant contributor of reviews and extracts upon matters of railway and general Corps interest to the *R.E. Journal.*

Of a somewhat retiring nature, Vickers worked most unobtrusively though assiduously, and it was perhaps only those who were personally in contact with him and what he did who properly realized his great ability, his intense capacity for hard work, and his conscientiousness. Genial, unselfish, and kindhearted, he had many friends, and his influence was ever for good. It was a trait of his character that he was always much liked as well as respected by all those under him, who would have done anything for him.

E. D. SWINTON.

THE LATE SIR H. TYLER.

CAPT. SIR H. TYLER, whose memoir appeared in last month's *Journal*, should have been described as a Knight Bachelor instead of a K.C.B.

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REVIEWS.

PANORAMA SKETCHING.

In recent years Panorama Sketching has come to the front chiefly owing to its having been made a subject of examination for the Staff College. The result is the publication of books on sketching, the most recent of which are by Capt. P. E. Lewis, R.F.A., and by Capt. A. F. Green, R.G.A. Both books are published by Hugh Rees, Ltd., 119, Pall Mall.

The book by Capt. Lewis, *Panorama Drawing*, price 1s. 6d., is a short treatise containing the essential information for producing a simple clear sketch. It is divided into three subheads:—(1) How to draw a panorama from nature; (2) How to draw a panorama from a map; and (3) How to draw a contoured sketch from a panorama. Three plates are inset at the end of the book, one giving a scale for reading angles at sight from a contoured map, and the other two giving practical examples of a panorama drawn from a map and one drawn from nature.

Capt. Green's book is more pretentious. It is divided into eight chapters, dealing with Equipment Hints; Conventional Signs; Procedure—Finishing up; Shading; Perspective; Reproductions in the Field; A Chapter on Hints; and Panoramas from Maps, and *vice versâ*. Both authors deal with their subject in a clear and methodical manner.

The present fashion is not only to make landscape sketches from nature, but also to make them from maps, and *vice versâ* to construct maps from landscape sketches. Hence both authors are constrained to deal with these latter developments. As ingenious exercises for the student they may have some value, but little reliance could be placed in practice upon the results produced. This is acknowledged by Capt. Green, who devotes some space to the praise of landscape sketching as a military study. With many of his conclusions one may agree, but he rather runs *amok* on the subjects of Photography and Map Reproduction. Without a sufficient acquaintance with those subjects it is unfair to condemn them.

Under conditions suitable for useful panorama sketches, photography with the aid of ortho-chromatic plates, the colour screen, and the stereoscope can produce more accurate and generally better military results in less time than the landscape sketches. Hence, the question is not, as Capt. Green supposes, as to which is the more efficient, but as to whether such views, however good, are of sufficient practical value in war to justify the expense of photographic *personnel* and equipment. As in country with marked features their value has been proved, there is little doubt that the answer in such a case is in the affirmative.

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TRAINING AND TACTICS.

By CAPT. H. M. JOHNSTONE, LATE R.E.—(Oliver & Boyd).

A small, handy little volume of 166 pages—of the same size as the training manuals—and well arranged and printed.

The book is intended as an aid to the study of infantry and combined trainings, and is specially written for officers of the Territorial Forces. It should, however, prove very useful to all those officers who have to do with the training of the soldier. It is written in a clear and pleasant style, and the subject-matter is logically and convincingly dealt with. Each principle is illustrated by excellent little company and section schemes. Although in the main the author follows the training manuals, he occasionally criticizes them, as for example, in his remarks on the "Holding Attack" (on page 110). Starting with the training and tactics of the individual soldier, the author next deals with the tactics of the section and company in chapters on "The Service of Security," "Patrols," and "The Company in Combat." A very useful chapter called "Some Principles" gives a *résumé* of more general tactical principles. "Attack and Defence," "Field Fortification," "Orders and Reports," and "Marching" are also more generally dealt with. Lastly, a small, concise appendix gives a useful summary of the organization of the three arms. Although neither taking the place of, nor intended to take the place of, the training manuals, this small volume will prove a great boon to many company and half-company commanders.

WEAPONS.

By B. E. SERGEAUNT.—(Hugh Rees, Ltd. Price, 2s. 6d. net).

Mr. Sergeaunt—who is assistant curator of the R.U.S. Museum—has done his work thoroughly, and under the headings of "Weapons for Stunning," "Weapons for Cutting," "Weapons for Thrusting and Stabbing," and "Miscellaneous Weapons" has given a very interesting account of "Hand Weapons other than Firearms."

The book deals with a variety of weapons, both of ancient times and the present day. Little-known weapons such as the morgenstern, the voulge, the gisarme, the partizan, and the misericorde are fully explained. The book is well illustrated with photographs of the various weapons described, and is likely to prove very welcome to those interested in the subject.

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CORRESPONDENCE.

JOHN HEPBURN, ENGINEER AND CLERIC.

DEAR SIR,

I found the enclosed letter a few days ago among some original correspondence of the Earl of Peterborough's dating between the years 1705–1711.

There is no mention of this Rev. Engineer in Porter's *History of the Corps*, and the letter would therefore seem to be of sufficient interest to publish in the *Journal*.*

Let us hope that Mr. Hepburn ultimately succeeded in getting a "Living in the Queen's Guift," especially as the Duke of Marlborough, Lord Sunderland, and Sir Charles Hedges seem to have considered his services as an Engineer at Gibraltar qualified him so well for the Church!

Yours very truly,

M. ELRINGTON-BISSET,

The Editor, *R.E. Journal.* *Capt., late R.E.*

P.S.—The rev. gentleman's arithmetic is somewhat shaky. He seems to have been due £630 instead of £530.

TO HIS EXCELLENCY THE EARL OF PETERBROUGH.

A Memorial of the service of John Hepburn Engineer. First by the orders of Her Majties most Honble Privy Councill. Afterwards under your Excellencies command in Spaine.

In the year 1702 after the English took Gibraltar, there being no Engineers there, I made an exact Draught and Survey of the Fortifications with a particular account of the Ruins and defects thereof and proposed the best method to repair and improve them. This I brought into England and presented to the Most Honble Privy Councill who referred me several times to be examined by Sir Henry Sheers who returned two letters in my favour, importing that I was very well qualified to serve as Engineer at Gibraltar or any where else: upon this account Sir Charles Hedges often promised me the first living that fell in Her Majties guift because my share of the prizes that were taken by the ship whereof I was Chaplain, during my being on shore by order of the Most Honble Privy Councill, amounted to above Two hundred pounds My expences with my servants for eight months was at least £100. But instead of the performance of Sir Charles Hedges repeated promises or any consideration for the loss of my Prize money and great expences my ship of near £200 per annum was taken from me and I thrown intirely upon your Lordship's generosity.

The first service I was put upon by your Excelcy was to draw the lines between the detachment you left with the King, and Barcelona which I humbly presume was done to your Lordship's satisfaction. After this I attended your Excelcy at the other Camp & you ordered me

* He is not however overlooked in the *Roll of the Corps*, published by the R.E. Institute, and is shown in it as "ultimately becoming Chaplain to Colonel William Stanhope's Regiment of Dragoons."—ED., *R.E.J.*

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immediately to attend Brigadier Richards during the Siege. Two days after Adjutant Collier was wounded and I did both his duty and my own. Two days after that Brigadier Richards was wounded so that the two last days of the siege I did the whole duty of the Trenches and was myself wounded by the last guns that was fired from the Town, and was eighteen days in Hospital and in great danger of loosing my leg.

The next duty I was put upon by your Excelcy was in Alcira. and to avoid all Imputations against me I wrote a letter to Mr Furly sixteen days before the Town was besieged that I would not take upon me to defend the Town, And desired him to communicate the same to your Lordship and record it.

The last duty I did was at Tortosa, from the Governr thereof I brought your Excelcy an honourable certificate, Notwithstanding some accidents I had there he did not approve. And as yet I have not received the least compensation for the damages susteined which are as follows :

	£
My Prize Money about	200
My own and Servants attendance By order of the Most Honble Privy Councill 8 months	100
My baggage was lost with your Excellencies	100
The Princes Councill took my ship away from me	130
A year out of all Business	100
TOTAL	£530

This is all I can be accused of getting by being an Engineer. Though His Grace the Duke of Marlborough was pleased to tell me he believed I very well deserved a living in the Queens guift and added he would speak to my Lord Sunderland about it, and my Lord Sunderland told me he had, and that His Lordship himself would do what he could for me.—

Copied from the original in my possession.

M. E. BISSET.

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RECENT PUBLICATIONS OF MILITARY INTEREST.

APRIL, 1908.

(*Published Quarterly*).

THE following extracts from the list compiled by the General Staff, War Office, are published in the *R.E. Journal* by permission of the Army Council.

HISTORICAL.

MODERN EGYPT. By the Earl of Cromer. 2 vols. 594 and 600 pp. With map. 8vo. London, 1908. Macmillan. 24s. the two volumes.

Lord Cromer, after a brief introduction, outlines the political history of Egypt from 1863 to 1876, and discusses the financial crisis which led to intervention by the Powers of Europe, and notably of France and Great Britain. The author shows that the institution of a Commission of Inquiry into the finances of Egypt was a necessary corollary to this intervention, and how Ismail Pasha endeavoured unsuccessfully to wreck the Commission by means of a *coup d'état* designed to rid the country of European advisers.

After the deposition of Ismail in 1879, Great Britain and France re-established a joint control over Egypt, and Sir Evelyn Baring (Lord Cromer) was appointed British Controller, a position he held until June, 1880.

From the beginning of 1881 the want of discipline in the Egyptian Army gave serious cause for alarm, and after two successful mutinies the army got completely out of hand, the authority of the Khedive was destroyed, and Egypt was reduced to a state of anarchy. An outbreak against Europeans at Alexandria in June, 1882, brought matters to a crisis. Arabi Pasha, the leader of the military party, had become "a power to be reckoned with."

The action of the British Government in ordering the bombardment of Alexandria is described by Lord Cromer as being "perfectly justifiable, because it was clear that, in the absence of effectual Turkish or International action, the duty of crushing Arabi devolved upon England." Arabi withdrew his army from the vicinity of Alexandria after the bombardment, and issued a proclamation stating that irreconcilable war existed between the Egyptians and the English.

Lord Cromer writes: "The history of the next two months may be summarized in a single sentence. England stepped in, and with one rapid and well-delivered blow crushed the rebellion." The author, however, shows that England acted alone only after every diplomatic resource had been exhausted in the endeavour to persuade

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the French, Italian, and Turkish Governments to co-operate in the work.

After Tel-el-Kebir, in September, 1882, and the final rout of Arabi's Army, Lord Dufferin was sent to Egypt to report on the situation, and the result was that a policy of reform was adopted which connoted with an indefinite prolongation of the British occupation and the abolition of the dual control, which was only effected after some sharp diplomatic skirmishing with France. It then became clear that for some long while to come the representative of the British Government in Egypt would of necessity be more than an ordinary diplomatic agent. Sir Edward Malet having been promoted, the British Government offered the appointment to Sir E. Baring, who accepted the offer, and arrived in Egypt in September, 1883.

Part III. of Lord Cromer's work deals with the story of the Sudan from 1881 to 1907. After describing the vast area over which the Khedive still exercised a nominal control, and after calling attention to the misgovernment that existed throughout the country, Lord Cromer shows that everything was ripe for a successful rising when a man named Mohammed Ahmed proclaimed himself Mahdi of the Sudan in 1881.

Egypt at this time maintained garrisons at Khartoum, El Obeid, and other distant places in the Sudan, but when in the spring of 1883 the Mahdist movement had become formidable, the military and financial resources upon which Egypt could rely to quell the rebellion are thus described by Lord Cromer: "The Treasury was exhausted; the army was unpaid, undisciplined, untrained, partially disloyal, and, therefore, worthless as a fighting machine." These facts were well known to the British Government of the day, and Lord Cromer censures it for not interfering in the despatch of the ill-fated expedition under General Hicks from Dueim in September, 1883.

The policy of evacuating the Sudan was now urged by Sir Evelyn Baring, accepted by the British Government, and finally acquiesced in by the Egyptian Government, and in answer to popular clamour in England, General Gordon was sent to Khartoum early in 1884 to concert measures for the withdrawal of the Egyptian garrisons still in the Sudan. But after the defeat of General Hicks, events followed each other with startling rapidity: Egyptian troops were defeated at Tamanieb; Slatin Bey surrendered Dara, and the Province of Darfour fell into the hands of the Mahdi; General Valentine Baker's force was defeated at El Teb; Berber fell, and Khartoum was cut off and besieged by overwhelming numbers of Dervishes. The only success among this series of disasters was the victory of Sir Gerald Graham's force at Tamai.

Lord Cromer deals with these events in a forcible and impartial manner. He criticizes the dilatoriness of the British Government in despatching a force to the relief of Gordon, but eulogizes the gallantry of the British troops, and the strenuous efforts made by all, when once the expedition started, to arrive in time. While he calls

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attention to a want of consistency in some of General Gordon's actions, he nevertheless pays an eloquent tribute to the bravery and devotion of this national hero :—

"History has recorded few incidents more calculated to strike the imagination than that presented by this brave man, who, strong in the faith which sustained him, stood undismayed amidst dangers which might well have appalled the stoutest heart. . . . Hordes of savage fanatics surged around him. Shot and shell poured into the town which he was defending against fearful odds. Starvation stared him in the face."

Lord Cromer, in reviewing this period, makes the following comments :—

"Looking more closely to the details in the execution of the British policy, the following are the conclusions at which I arrive :—

"In the first place, it was a mistake to send any British official to Khartoum. The task he had to perform was well-nigh impossible of execution, and his nomination involved the assumption of responsibilities on the part of the British Government which it was desirable to avoid.

"Secondly, if anyone were to be sent, it was a mistake to choose General Gordon. In spite of many noble traits in his character, he was wanting in some of the qualities which were essential to the successful accomplishment of his mission.

"Thirdly, when once General Gordon had been sent, he should have been left a free hand, so long as he kept within the main lines of the policy which he was authorized to execute. It is, in my opinion, to be regretted that General Gordon was not allowed to employ Zobeir Pasha, but any view held as to the probable results of employing him must be conjectural.

"Fourthly, the question of whether an expedition should or should not have been sent from Suakin to Berber in the spring of 1884 depends on the military practicability of the undertaking, a point on which the best military authorities differed in opinion.

"Fifthly, a great and inexcusable mistake was made in delaying for so long the despatch of the Gordon Relief Expedition.

"Sixthly, the Government acted wisely, after the fall of Khartoum, in eventually adopting a defensive policy, and in ordering a retreat to Wadi Halfa."

Lord Cromer raises another point which was much discussed at the time, namely, the delay of three days in despatching steamers from Gubat after the arrival of the desert column at that place on the 21st January, 1885.

"If the steamers had left Gubat on the afternoon of the 21st they would probably have arrived at Khartoum in time to save the town." This conclusion is probably sound.

Lord Cromer states that it is beyond the scope of this work to write a detailed history of the military operations which took place in the Sudan, but he gives a brief summary of the chief events connected with the Nile Campaign of 1884–85.

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On receipt of the news that Gordon had been killed and Khartoum taken, British public opinion was so intensely aroused that it appeared probable for a time that active operations would be undertaken for the recapture of the town, but, eventually, it was decided to pursue a more logical course and to withdraw the British troops to a good strategical position in the valley of the Nile and to there await the attack of the Mahdist forces.

The years from 1886 to 1892 were devoted to the defence of Egypt proper north of Wadi Halfa and to maintaining an Egyptian post at Suakin.

Although British military aid to a limited extent was subsequently on one or two occasions afforded to the Egyptian Government, it may be said that from the date of the Battle of Ginniss (December 30th, 1885) the defence of Egypt against the Dervishes practically devolved on the Egyptian Army.

The Egyptian Army as it existed prior to Tel-el-Kebir was disbanded immediately after that battle and the work of reorganizing it was entrusted in the first instance to Sir Evelyn Wood and a devoted body of British officers. Lord Cromer shows how its organization and fighting efficiency gradually improved under the methods inaugurated by Sir Evelyn Wood and continued under his successors, Sir Francis Grenfell and Sir Herbert Kitchener, with the result that when the re-conquest of the Sudan was begun in 1895 the Egyptian Army had been converted into a formidable fighting machine.

Speaking of the final stages of the Khartoum campaign in which the Egyptian Army was reinforced by British troops, Lord Cromer writes :—

"Early in August (1898), the Sirdar (Lord Kitchener) whose calculations of time were never once at fault, warned me that I ought to be back in Cairo by September 1st. . . . The long-expected battle took place under the walls of Omdurman on September 2nd. . . . The Dervish loss was, in truth, terrible. Out of an army whose strength was estimated at from 40,000 to 50,000 men, some 11,000 were killed, and about 16,000 wounded. . . . The financial success was no less remarkable than the military. The total cost of the campaigns of 1896–1898, was £E.2,354,000, of which £E.1,200,000 was spent on railways and telegraphs and £E.155,000 on gun-boats. The military expenditure, so called, only amounted to £E.996,000. Of the total sum rather less than £E.800,000 was paid by the British. The conditions under which the campaign was conducted were very peculiar. . . . The Sirdar was, from the commencement of the operations, placed under my orders in all matters. The War Office assumed no responsibility and issued no orders. The result was that I found myself in the somewhat singular position of a civilian who had had some little military training in my youth but who had had no experience of war, whose proper functions were diplomacy and administration, but who under the stress of circumstances in the

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'Land of Paradox,' had to be ultimately responsible for the maintenance of even to some extent for the movements of an army of some 25,000 men in the field."

The Sudan having been reconquered, the question of the future political status of the country naturally presented itself for solution, and Lord Cromer explains the political reasons which rendered it "necessary to invent some method by which the Sudan should be, at one and the same time, Egyptian to such an extent as to satisfy equitable and political exigencies and yet sufficiently British to prevent the administration of the country from being hampered by the international burr which necessarily hung on the skirts of Egyptian political existence." Lord Cromer devised such a method, and the flags of Great Britain and Egypt which now float side by side throughout the Sudan betoken that the Sudan is governed by a partnership of two, of which England is the predominant partner.

Under the new *régime*, the Anglo-Egyptian official is described as requiring qualifications of the highest order, and comparing the position of military and civilian officials, Lord Cromer says: "The British officers of the Egyptian Army have had to contend against considerable difficulties, but as compared with their civilian colleagues, they have from one important point of view been at an advantage. There is a reality about the position of the soldier which does not exist in the case of the civilian. . . . The Sirdar is, therefore, master of the situation. . . . He is not obliged to trim his sails to every passing political breeze."

Lord Cromer devotes the remainder of his work, which he hopes will be of some special interest to those of his fellow countrymen who are or who at some future time may be engaged in Oriental administration, to discussing the Egyptian Puzzle; British policy in Egypt up to 1887 with one chapter devoted to the subsequent Anglo-French Agreement of 1904; the reforms effected, and a concluding chapter on the future of Egypt.

THE SECOND AFGHAN WAR, 1878-80. Abridged Official Account. Produced in the Intelligence Branch, Army Headquarters, India. 631 pp., with appendices, maps, and plans. 8vo. London, 1907. Murray. 21s.

This book was originally the work of Major-General Sir C. MacGregor, and was produced in the "eighties," but was treated as a secret work. It has now been revised and produced by Major Cardew, Indian Army, and the Intelligence Branch of Army Headquarters, India.

The book gives a detailed and voluminous account of the operations from October, 1878, to the close of the war in the end of 1880, and contains numerous maps, plans, and illustrations.

The nature of the campaign was such that a full account must be a somewhat disjointed narrative, so the different phases in each theatre are dealt with in turn.

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It includes a number of despatches which are, in many cases, very interesting, especially those of Lord (then Sir F.) Roberts, in Chapter XII., and those of Sir D. Stewart.

The accounts of the principal engagements are clear, and accompanied by good plans and sometimes by eye-sketches, which give the reader a very good idea of the country.

Although plans are given of nearly every skirmish and engagement, some of which were of very small importance, there is no general map of the country over which the operations extended, and there is no map of the line of communication from Peshawar to Kabul, nor of the line of communication from Quetta to Kandahar. This fact very much detracts from the value of the book, for, with the exception of the operations in the immediate vicinity of Kabul and Kandahar, it is impossible to follow the course of events, and numbers of places are mentioned the exact location of which can only be a matter of guesswork for the uninitiated or the general reader who does not happen to be provided with an atlas.

We should say that the book had a greater value as a record than as a military history, for, owing to the defects mentioned above, it is difficult for the student to extract those lessons which are the valuable result of studying campaigns. There is little or no account of such points as the organization of the lines of communication and generally of the working of the administrative services, though the difficulties of supply and transport are clearly brought out in some of the despatches, notably in Chapter XI. These difficulties, which occurred on both the northern and southern lines, prove the extreme difficulty, if not impossibility, of employing large forces in Afghanistan without railway communication. There are references to the scales of rations in Appendix XIX. and other places, but it would have been better and more easy for reference had such subjects been grouped under their separate headings and not interspersed among the accounts of the operations.

As readers will have to consult maps, a list is given below of those most likely to be useful :—

1. General map of Afghanistan.—Map of Afghanistan published by General Staff in 1906. 1 inch to 32 miles.
2. Frontier as settled by the Treaty of Gandamak, and for communications in the early stages of the war.—Stanford's large-scale map of Afghanistan, published 1879. 1 inch to 22 miles.
3. Communications in later stages.—Map of Afghanistan published by Survey of India, 1883. 1 inch to 24 miles.
4. For operations of line of communications (more detailed study).—N.W. Trans-Frontier Survey. 1 inch to 8 miles. Sheets 27, 28 for northern lines, sheets 21, 21 S.E. for southern.

SPICHEREN (6TH AUGUST, 1870) (Spicheren, 6 août 1870). By Lieut.-Colonel Maistre, 79th Infantry Regiment, and former Professor

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at the Staff College. With a Preface by General H. Langlois. 420 pp., with 9 maps and 10 panoramic views. 8vo. Paris, 1908. Berger-Levrault. 10s.

General Langlois contributes a preface to this volume, in which he urges the importance of the study of the war of 1870–71, because it was fought in Europe, and because its events and lessons are thoroughly known and have been impartially discussed in the sober light of history. He points out, on the other hand, that the Manchurian War is of too recent date for its teachings to be fully accepted and to be of real value in every respect; it was, moreover, like the South African War, though in a lesser degree, fought under conditions very different to those which would obtain in a European war. The South African War produced a whole crop of false conclusions; though the Russo-Japanese War has done a great service in correcting a number of these, care must be taken to prevent it from creating a fresh series of ideas and theories, of a different nature, but almost equally unsound and misleading.

General Langlois therefore agrees with the author in his view that, for a European nation, the thoroughly digested lessons of 1870–71 are still of very great importance. The story of this war has been told so many times, and in such detail, that it would seem difficult to write anything fresh on the subject. Lieut.-Colonel Maistre, however, has set himself the task of dealing with the personal equation in the Franco-German War, the tactical training of the troops, the qualities of the higher leaders, and above all, the spirit which animated the opposing forces, from general to private soldier. He is of opinion that the disasters suffered by his countrymen were mainly attributable to the loss of the offensive spirit, which was as striking a characteristic of the French armies of the First Republic and of the First Empire, as it was of the Prussians in 1866 and of the Germans in 1870. With the object of dealing at length with the question of *moral*, Lieut.-Colonel Maistre determined to make a thorough and searching analysis of one of the great battles of 1870; he chose Spicheren as the most suitable for his purpose, a battle which he describes as the "apotheosis of the initiative."

The object of this volume is not to attack individuals, but the system by which brave men and talented generals were robbed of their energy and power of action, a system of inaction and want of initiative which would have paralyzed any army and any leaders, and was more especially foreign and repugnant to the particular genius of the French nation. The author emphasizes the fact that no army can win victory by contenting itself with merely repulsing an enemy and warding off his blows; the surest road to success is by means of attack, a constant and energetic offensive, and a determination to conquer, which will repair any temporary checks that may be caused by an excess of ardour on the part of individual commanders: if, however, a defensive attitude should be temporarily imposed upon an army, then its commander must be prepared and

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determined to assume the offensive on the first favourable opportunity, to wrest the initiative from the enemy, and to crush him by a decisive counter-attack delivered by a powerful general reserve.

General Langlois also lays stress on the fact that it seems highly likely that France's next great war will again be fought against her ancient enemy, Germany, whose troops will be animated with the same spirit of the offensive as in 1870; he dwells on the necessity of cultivating the initiative, a plant which grows slowly and requires constant attention. He concludes with a few words of praise for Lieut.-Colonel Maistre's work, which he is sure will attain its object of "seeking in the wars of the past the lessons which will prepare us for the wars of the future."

Lieut.-Colonel Maistre's history of Spicheren is accurate, impartial, and interesting; it is, of course, written with a particular object, that of proving that the defeat of his countrymen was due to false doctrines and over-confidence, to a lack of enterprise and initiative: that the Germans owed their victory to their offensive spirit, and to the energy and initiative of their leaders, not to any superiority in courage or endurance. He has pleaded his cause with eloquence and, we think, with success; it was not the French soldiers who were defeated at Wörth, Spicheren, and Vionville, but their leaders, whose natural abilities had been blunted by false theories and vicious doctrines.

The arguments employed by the author are clear and convincing; he writes with knowledge and conviction, and with an evidently strong sense of a patriotic duty—that of educating his countrymen and of inculcating in them the moral qualities which are necessary for success in war. He is a member, and an able member, of the great school of thought presided over by such men as Generals Bonnal and Langlois, whose lives are devoted to the attempt to teach the French nation the spirit of modern war. They believe in the necessity of the offensive; that success can only be obtained by attack, preferably by constant attacks, like the Germans in 1870–71, and the Japanese in 1904–05, but, if necessary, by defensive action; always provided that it be followed by a resolute and vigorous counterstroke.

Lieut.-Colonel Maistre points out very clearly the disastrous results that are certain to accrue from a merely passive defensive action. At Spicheren, as in other battles, the French made use of their reserves for local counter-attacks and *retours offensifs;* there was, however, no determination to conquer by means of a great stroke by a powerful general reserve, and therefore the French were invariably beaten, just as and for the same reason that the Russians were constantly defeated in Manchuria.

The author compares the vigour and energy of the Prussian generals, especially von Alvensleben, whose determination to conquer secured the victory, with the want of offensive spirit shown by the French leaders, who only sought to maintain their positions and not to defeat the enemy. He also emphasizes the necessity for mutual

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co-operation, both on the field of battle and in marching to the sound of the guns.

The book abounds in able criticisms and valuable lessons; the views expressed and the principles enunciated are fully in accordance with the teachings of our own regulations, with the result that the volume cannot fail to be of considerable interest and utility to the British officer and student of military history.

THE CAMPAIGN IN BOHEMIA, 1866. By T. Miller Maguire, M.A., LL.D. Reprinted from the *United Service Magazine*. 33 pp. 8vo. London, 1908. 2s. 6d.

This little book, which is designed to convey a clear idea of the principal features of the war of 1866, is the result, as the author says in the preface, of the translation of a series of articles which were written by an anonymous writer, and which appeared in *La Revue des Deux Mondes*, in 1868.

The author himself summarizes the events which led to the war, and adds some remarks on the strategy and results of the campaign.

THE AUSTRO-PRUSSIAN WAR IN BOHEMIA, 1866. By J. H. Anderson, F.R. HIST. SOC. 88 pp., with maps and plans. London, 1908. Rees. 3s. 6d.

This is a condensed account of the 1866 campaign, with comments. There is a good general map, and there are plans of the various actions. The plans are not of very much assistance to the reader, for they in no way show the features of the ground. This book may be useful as a companion to larger works.

WATERLOO.—OPERATIONS OF THE PRUSSIAN ARMY OF THE LOWER RHINE (Waterloo.—Opérations de l'armée prussienne du bas-Rhin). By Winand-Aerts. 316 pp., with sketches and photographs. 8vo. Brussels, 1908. Spineux. 4s. 3d.

This is an account of the Waterloo Campaign from the point of view of the Prussian Army. The book commences with a review of the Prussian Army from 1806 to 1815, as regards organization, *moral*, leadership, and tactical training. Discussing the events of the 16th June, reference is made to the well-worn controversy as to whether Wellington induced Blücher to fight at Ligny in order to cover his own still uncompleted concentration; the authorities on either side are cited, but no conclusion is arrived at. Neither can the author throw any fresh light on the movements of d'Erlon's corps during the battle of the 16th. The delay in giving Grouchy his orders on the morning of the 17th is, perhaps, reasonably accounted for by the Emperor's desire to have fuller reports from his cavalry (Pajol) as to the alleged retreat of the Prussians on Namur, and by the vague reports sent in by Ney as to the fighting at Quatre Bras.

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Gneisenau's despatch on the Battle of Ligny is cited to show that Wellington accepted battle at Waterloo on condition of Blücher's co-operation with two corps, while Gneisenau's hesitation and evident mistrust of the English is in striking contrast with Blücher's determination to come "not with two corps, but with my whole army."

In considering to whom the chief merit is due, the author divides the honours. The two Staffs were in frequent communication. Wellington would not have fought at Waterloo had Blücher not promised to co-operate, nor would Blücher have moved to Mount St. Jean on the 18th had Wellington retired on Ostend after Quatre Bras.

The book is a readable and impartial account, but throws little fresh light on the old controversies.

PRÉCIS OF GREAT CAMPAIGNS, 1796–1815. By J. H. Anderson, F.R. HIST. S. 138 pp., with maps and plans. 4to. London, 1907. Rees. 10s. 6d.

This book is divided as follows :—

1. First Coalition, 1796–7.
2. French Expedition to Egypt and Syria.
3. Second Coalition, 1798–1801.
4. Third Coalition, 1805.
5. Fourth Coalition, 1805–7.
6. Fifth Coalition, 1809.
7. Campaign in Russia.
8. Sixth Coalition, 1813–14.
9. The Peninsular War, 1807–14.
10. The Seventh Coalition, 1815.
11. The War with the United States, 1812–15.

Appendices give details regarding the great Generals of both sides, French military institutions, the frontiers of France, fortresses and the military forces of England, Russia, Prussia, and Austria.

The book is, as its title indicates, only a *précis* of the campaigns above indicated, but the accounts given are easily followed, and the maps are good and clear. Maps are given of the campaign areas and of most of the principal battles, though, curiously enough, Salamanca and Vittoria are omitted. The book may be recommended as a companion to the more detailed accounts of the campaigns with which it deals, but though it gives short general remarks and strategical and tactical comments, the lessons to be learnt by a campaign cannot be studied by a perusal of a *précis*. It will, however, be useful as a book of reference. In the appendix the author draws attention to the fact that all the great generals of that time studied assiduously.

NAPOLEON. Vols. III. and IV. (First two volumes published in 1904). Great Captains series. By Theodore Aynault Dodge, U.S. Army. Vol. III., 747 pp. Vol. IV., 741 pp. Appendix and Index.

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Illustrated and numerous maps. 8vo. London, 1907. Gay & Bird. 18s. each volume.

A narrative of the campaigns from 1808 to 1815, furnishing a study of the causes which led to Napoleon's downfall. His rise to power is dealt with in Vols. I. and II. This work is a study of the military life of Napoleon; political events and personal matters are only touched upon to throw light on Napoleon's character as a soldier. A valuable work for the purely military student.

THE EMPEROR NAPOLEON'S CAMPAIGN IN SPAIN (1808–09) (Campagne de l'Empereur Napoléon en Espagne, 1808–09). By Commandant Balagny. 4th volume, 546 pp., 8 maps and sketches. 5th volume, 563 pp., 5 maps and sketches. 8vo. Paris. Vol. IV., '06. Vol. V., '07. Berger-Levrault. 10s. each volume.

The 4th volume of this important work deals with the operation connected with the Battle of Benavente, December 24th, 1808, to January 2nd, 1809; the pursuit of the English Army, January 2nd to 16th, 1809; the operations in Galicia in January, 1809; the retreat of Sahagun and the operations of the English armies up to January 16th.

The 5th volume gives an account of the operations round Madrid, December 22nd, 1808, to January, 1809, and the history of the war up to the departure of Napoleon. The correspondence of Napoleon and the French general staff is fully given.

SEYDLITZ (Seydlitz). By Colonel Emil Buxbaum. 4th edition. 216 pp., 5 illustrations, and 3 maps. 8vo. Leipzig, 1907. Wigand. 7s. 6d.

The book deals with the early life of this great cavalry leader, and chapters are devoted to following his career through the grades of squadron leader, regimental commander, and finally Inspector-General of the Silesian cavalry. His vicissitudes during the Seven Years' War are closely followed, an account of which campaign is concisely given in Chapter IV. The Battles of Rossbach and Zorndorf are dealt with in some detail, more especially as regards the action of the cavalry, which is graphically described. Not the least interesting portion of the book is that contained in the few pages of Chapter V. which deal with the excellent tactical qualities of this cavalry soldier and his aptitude for interpreting, and applying correctly, the tactics as laid down in the regulations of the period for the Prussian cavalry.

MILITARY HISTORY AND ART (2nd Part). Vol. II.—The War, 1870–71. Vol. III.—The Wars from 1871 to 1905: Oversea Expeditions, Mountain Warfare. Histoire et Art Militaires, by General Frédéric Canonge, former Professor of l'École Supérieure de Guerre. Vol. II.—696 pp., 81 maps and sketches. Vol. III.—540 pp., 67 maps and sketches. 4to. Paris. Vol. II., 1902. Vol. III., 1905. G. Fanchon. Vol. II. (2nd Part), 20s. Vol. III., 16s.

Previously published:—Vol. I. (1st Part), Dès l'Origine à 1786. Vol. II. (1st Part), from 1853 to 1870.

Both "Couronné" in 1904 by the Académie Française.

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Vol. II. is divided into three parts, which deal respectively with the events which led up to the war and the history of the war up to the end of the Empire, the history of the national defence up to the fall of Paris, and from that time to the conclusion of peace.

The author describes the war as the victory of science and reflection over ignorance and presumption.

This is a well-arranged and detailed critical history of the war.

In the first part of Vol. III., 93 pages are devoted to a study of the Russo-Turkish War of 1877–78 in both theatres, and 94 pages to the Russo-Japanese War.

The Greeco-Turkish and Spanish-American Wars are dealt with shortly.

The second part contains studies of the following French oversea campaigns:—China, 1860; Mexico, 1861–1867; Tonkin, 1881–1885; Dahomey, 1892–1894; Madagascar, 1895; and the British campaigns in Abyssinia, 1868; and Transvaal, 1899–1900. The China War, 1900, 1901 is briefly referred to, and some notes of medical and veterinary interest are given.

The third part of this volume comprises short accounts of campaigns in the Alps and Tyrol from 1635 to 1866.

POLITICAL.

THE HUNGARIAN QUESTION FROM A HISTORICAL, ECONOMICAL, AND ETHNOGRAPHICAL POINT OF VIEW. Translated from the Hungarian by Ilona and C. Arthur Ginever. 95 pp. 8vo. London, 1908. Kegan Paul. 2s. 6d.

The translators state that this book was written by a distinguished Hungarian publicist with the object of making Hungary's attitude on military and economic questions, and on her relations with Austria, comprehensible to English readers, and they explain that information concerning Hungary usually comes through Viennese channels, and takes a distinctly Austrian colour in its course, the number of English journalists who are acquainted with the Hungarian language being exceedingly small.

The book contains a sketch of the history of Hungary and of the relations between that State and Austria. This is followed by a discussion of the ethnical situation in Hungary and of the language question. The author then deals with the chief problems of the crisis and their solution, and attempts to discover what he terms "a practical policy which can lead, without very great disturbance, to such a transformation in the relations between Hungary and Austria as shall accord with the distribution of strength among the nations ruled by the Habsburgs, and shall thus create a real organic link between the countries in place of the existing ties which are purely mechanical."

In conclusion the writer states that the Hungarian Kingdom is predestined to become very soon a united and solid State, while Austria, on the other hand, is driven towards a federal organization

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of her separate nationalities. The direct and final aim of the Hungarian people cannot be the establishment of an entirely separate Hungary. An endeavour must be made to place the monarchy, while still ruled by the Habsburgs, upon natural foundations, and Hungary must then stand at the head of the new confederacy of States. The Hungarian question will thus be solved so as to promote the interests both of the Hungarian nation and of the Habsburg dynasty.

EUROPE AND THE TURKS. By Noel Buxton. 143 pp., 2 maps. 8vo. London, 1907. Murray. 2s. 6d.

Mr. Noel Buxton is a member of the Macedonian Reform Committee and has, as he states in the preface, written this book with the object of inducing the British public to take a more active and intelligent interest in the Macedonian question. After sketching the past history of Turkey in Europe, he discusses the various factors in the problem of the Nearer Eastern Question and the cause of the present trouble in Turkey. He then examines the work of the Powers in their efforts to introduce reform in Macedonia, and submits a definite proposal in order that peace in that country may be secured.

THE SULTAN, ISLAM, AND THE POWERS (Le Sultan, l'Islam, et les Puissances). By Victor Bérard. 443 pp., 2 maps. 8vo. Paris, 1907. Colin. 3s. 4d.

This book deals with the two great railway projects at present on foot in the Ottoman Empire, viz., the Hejaz and Baghdad Railways, and discusses the relations between the Turks and the Arabs on the one hand, and between Turkey and the Powers on the other hand in respect to those projects.

THE NETHERLANDS AND BELGIUM (Nederland en Belgie). By R. Klerck. 110 pp. 8vo. The Hague, 1907. Van Stockum. 3s. 2d.

The author reviews the historical and legal aspects of Belgian neutrality, but can find nothing in the treaties examined to prevent Belgium from contracting defensive alliances. Stress is laid on the reality of the "German danger" for the Low Countries. The construction of the large military railway station at Daelhem, the objections raised to the fortifications of Liège and Namur, and the obvious advantages to Germany of the Dutch and Belgian harbours, are instanced in respect of this. As regards Holland, the book traces the persistent, though unsuccessful efforts of German writers to represent France as her enemy and Germany as her natural protector. Holland has, however, no real reason to seek an alliance with Germany, and the "English danger" to the Dutch commerce and colonies, which such an alliance might involve, is an important factor.

As regards the violation of Belgian neutrality, this is thought to be more probable on the part of Germany than of France, since the policy of the Republic has been eminently pacific (witness Fashoda and Algeciras). But the combined armies of Holland and Belgium would be too strong to be neglected by either belligerent, especially

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if Maestricht, Liège, and Namur were adequately fortified, so as to afford the field army the fullest liberty of manœuvre. Such an alliance, the author concludes, is most urgently to be desired both for economic and for military reasons.

THE COMING STRUGGLE IN EASTERN ASIA. By B. L. Putnam Weale. 640 pp., with one map and numerous illustrations. London, 1908. Macmillan. 12s. 6d.

The author has accumulated a mass of details, many of which are conveniently given in tabular form. The data concerning the defensive resources of the various countries in question are, generally speaking, accurate; his deductions are coloured, however, by strong sympathies which he does not attempt to conceal.

The book is divided into three parts:—

Part I. deals with Russia's Far Eastern possessions and Siberia.

Part II. treats of the Japanese sphere of influence in Manchuria. Japan's constitution, her system of finance, industries, commerce, and fighting resources, are next described. The last chapter, "Greater Japan," deals largely with Korea.

In Part III.. "The Struggle round China," the author discusses the recently instituted reforms in the Peking Government and the army, the internal condition of China and its attitude towards Europe and Japan. The concluding chapters of the book contain reflections on the position of the United States and Great Britain in the Far East.

An excellent description is given of Vladivostok, with its fine natural harbour. Despite the strong fortifications erected since the last war, the writer considers the position of the fortress as somewhat precarious. He comments on Russia's geographical weakness in the Ussuri province, owing to the interposition of Manchuria between it and Siberia, and on the facilities which the dense belt of forest, extending southward from the Vladivostok-Harbin line, along a portion of its course, would afford to an enemy advancing from the Tiumen river of placing himself astride of this the shortest link between Russia and her maritime province.

The writer draws attention to the influx of Chinese and Koreans into Vladivostok, the Ussuri province, and along the River Amur, and points to the impossibility of extensive Russian colonization alongside of this Asiatic immigration.

The abundance of cereals in Manchuria, and the erection of numerous flour mills, facilitated the rationing of the Russian field armies in 1904–5 "to a degree that contemporary military critics were quite unaware of."

Some interesting figures are given, illustrative of Russian railway work during the last war. At the beginning, six trains a day were run each way. In June, 1905, there were 16, "the maximum that could conveniently be handled." The speed had increased meanwhile from 5 to 8 miles an hour.

The various schemes of Russian railway expansion in Siberia are clearly depicted.

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The following are said to be projected :—

(i.). The extension of the Ekaterinburg-Tiumen (Western Siberia) line to Omsk, which is tantamount to doubling the western portion of the trunk line.

(ii.). The doubling of the Omsk-Tomsk section.

(iii.). The construction of a line from Tashkent, *viâ* Semipalatinsk, to join the Trans-Siberian Railway west of Lake Baikal, thus linking up the Caucasian and Siberian systems, and enclosing China from the west as well as from the north and north-east.

Regarding the position of the Russians in Asia, he observes : "In latent strength and reserves of men and materials their superiority is so vast that no one in the world can afford to ignore them or their future."

The author enlarges upon Japan's commanding position in Manchuria, resulting from her acquisition of the railway line up to Kuan-chêng-tzu, and speaks somewhat disparagingly of her colonizing methods in the new sphere. British officers who know Japan will agree that "in military, as in all other affairs, the Japanese mind has always inclined to finally adopt rigid Prussian methods."

His estimate of the total strength of the Japanese forces at the Battle of Mukden is too high.

Of China he says that, notwithstanding many defects in her military forces, she is now quite capable of policing her empire, and indulges in some interesting reflections as to the effect on international politics which a continued increase in her armed strength may entail.

The information about railway and mining concessions, about internal disorders, and the Chinese opinion on some recent conventions between Powers, will greatly assist students of Chinese affairs. Of interest, too, are the comments on the American position in the Pacific and the existing Anglo-Japanese alliance.

In spite of a certain exuberance of style the book is a most readable and instructive one.

STRATEGICAL AND TACTICAL.

NOTES ON THE DEVELOPMENT OF TACTICS FROM 1740 TO THE PRESENT DAY. By Major C. Ross, D.S.O. 42 pp. 8vo. London, 1908. Rees. 1s.

This is an outline of the development of tactics within the period above mentioned. Major Ross considers the period under the following headings :—

Period of Frederick the Great, 1744–1763.
Napoleonic Era, 1792–1815.
Wellington's Tactics, 1808–1815.
Crimean Period, 1854–1855.
Austro-Prussian War, 1866.
Franco-German War, 1870–1871.
Russo-Turkish War, 1877–1878.
Boer War, 1899–1902.
Russo-Japanese War, 1904–1905.

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Each period is divided into (*a*) Grand Tactics; (*b*) Infantry Tactics; (*c*) Artillery Tactics; (*d*) Cavalry Tactics. Major Ross concludes with some general remarks, in the course of which he outlines the possible future development of tactics, the general purport of which is that "the principle of success is immutable, but the application of this principle must be modified according to ever-changing circumstances." . . . "Secrecy and thoroughness in preparation, rapidity and resolution in execution; in these is comprised the whole secret of success in war. And these demand, inexorably, the display of the very highest qualities, both mental and physical, not only by the warriors of a nation, but by the nation as a whole."

Some of the conclusions drawn from the Boer War seem to be open to argument, but generally the book will be a useful one to students.

FRONTIERS (The Romanes Lecture). By Lord Curzon of Kedleston. 58 pp. 8vo. London, 1907. Frowde. 2s.

In Lord Curzon's words, "The majority of the most important wars of the century have been Frontier Wars. Wars of religion, of alliances, of rebellion, of aggrandizement, of dynastic intrigue or ambition . . . tend to be replaced by frontier wars, *i.e.*, wars arising out of the expansion of states and kingdoms, carried to a point, as the habitable globe shrinks, at which the interests or ambitions of one state come into sharp and irreconcilable collision with those of another." As instances of wars caused by frontier questions, Lord Curzon quotes the wars of '66, '70, '71, and the Russo-Turkish War of 1877, which, he says, originated in a revolt on the frontier states. Other instances he gives are the Afghan Wars of 1839 and 1878, the Tibetan Expedition of 1904, and he includes the Russo-Japanese War.

Besides the above, Lord Curzon gives various cases of recent frontier disputes, and shows how the British Empire has the greatest extent of territorial frontier of any dominion in the globe. From this subject he proceeds to discuss the origin of frontiers and natural frontiers which he classifies under the following types:—(1) Sea; (2) Desert; (3) Mountain; (4) River; and (5) Forest, Marshes, and Swamps.

The subject of natural frontiers leads on to artificial frontiers, "by which are meant those boundary lines which, not being dependent upon natural features of the earth's surface for their selection, have been artifically or arbitrarily created by man." Under this heading are considered neutral zones, buffer states, neutralixed states, and, finally, frontiers created by following a parallel of longitude and latitude by drawing a line from point to point, or by referring to some existing feature or condition.

Under the heading of modern expedients are considered Protectorates, giving Lord Curzon an opportunity of showing the results of the Durand Agreement of 1893, Spheres of Influence, Leases, and Spheres of Interest.

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Lord Curzon concludes with a statement of the evidences of modern progress in respect of the delimitation of frontiers and with a brief reference to the influence of frontiers on the American and British nations. In his peroration Lord Curzon calls on the Universities not to forget their mission, "still from the cloistered alleys and the hallowed groves of Oxford, true to her old traditions, but widened in her activities and scope, let there come forth the invincible spirit and the unexhausted moral fibre of our race."

From the above summary it may be seen that the lecture, though, as Lord Curzon says, it ignores large portions of the subject, is of great interest to all concerned for the safety, honour, and welfare of the British Empire.

ON WAR. By General Carl von Clausewitz. Translated by Colonel J. J. Graham. New and revised edition, with introduction and notes by Colonel F. N. Maude, C.B. (late Capt., R.E.). 3 vols., 315, 415, and 324 pp. 8vo. London, 1908. Kegan Paul. 21s.

An "Editor's Note" on page 9 of Volume III. dealing with a re-arrangement of the author's MS., would lead one to infer that the present text had been carefully compared with the original by Colonel Maude; a reference to the original, however, shows that the note was written by the "Editress," for von Clausewitz's papers were prepared for the Press by his widow. The translation under review appears to be a hurried reprint of Colonel Graham's one-volume work (issued in 1873), and reproduces even his errors of spelling; it has been expanded into three volumes by the use of smaller paper, larger type, and the employment of large capitals for the numerous headings. Colonel Graham's index, owing, no doubt, to the change of pagination thus introduced, has been omitted. The introduction is short, and the notes are few in number.

A considerable portion of Clausewitz's classic work has now only an historic value; this part might well have been given in the smallest type, so that the reader should not be fatigued by the perusal of it, but should be directed at once to the great and important truths of the philosophy of war contained in the remainder of the book. The editor has given no such help, nor has he attempted to attract readers by re-drafting Colonel Graham's somewhat heavy and closely-following-the-German periods.

It is much to be regretted that no cheaper translation of a work of such great importance to the Army should be available.

THE CAMPAIGN OF LANDSHUT (La manœuvre de Landshut: étude sur la stratégie de Napoléon et sa psychologie militaire depuis le milieu de l'année 1808 jusqu'au 30 Avril 1809). By General H. Bonnal. 360 pp., good and numerous maps. 8vo. Paris, 1905. Chapelot. 8s.

This book, written in easy French, gives a graphic and most interesting description of a campaign which is perhaps hardly as

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well known in England as it deserves to be. Napoleon himself considered this campaign to be one of his greatest masterpieces. In 1809 Napoleon was apparently at the zenith of his power, and believed himself to be infallible and his troops invincible; General Bonnal points out with his usual clearness and lucidity that the Emperor's genius was still as bright as ever, but that it was warped by overweening pride and conceit.

Napoleon remedied Berthier's initial errors of deployment with masterly skill, intuitively divined his opponent's intentions, and evolved a clever plan for the defeat of the Austrian Army. Up to this point his dispositions were brilliant in the extreme, but he now made several fatal mistakes; he attached too much importance to the moral influence of his own presence, and prepared to cut off the Archduke Charles' retreat, without waiting for the latter's army to be defeated. Instead of considering the capture of Vienna as the prize of a decisive victory, he made the fatal error of regarding the hostile capital as at once his primary and main objective, imagining that the magic of his name would be sufficient to transform a mere repulse into a rout. General Bonnal shows very admirably the extraordinary energy and rapidity of thought displayed by Napoleon, when, during the early hours of April 22nd, he realized his mistake; it was, however, too late, and the Emperor had allowed a great victory to slip from his grasp, a victory which would have spared him the bloody repulse of Aspern, and the doubtful success of Wagram.

General Bonnal has made a very deep study of Napoleon, whose genius and marvellous military talents he fully appreciates, whilst he does not hesitate to expose his faults and errors; the description of Napoleon's character, his methods, his military views and precepts, is most valuable. He deals with the various marshals, their failures and shortcomings, and shows how some of them, notably Masséna, had deteriorated, and had become indolent and tired of war; he also emphasizes their inability for independent action, which was to prove so fatal in 1813 and in 1815. On the other hand, he draws attention to the great qualities of Marshal Davout, still as resolute and skilful as at Austerlitz and Auerstädt, and makes the English reader congratulate himself that the marshal was left at Paris in June, 1815, instead of being in Ney's place on June 16th–18th.

Amongst numerous important lessons and points of interest brought out in this able work are the following:—

(1). The difficulty of remedying a faulty initial deployment, though General Bonnal considers that this difficulty is no longer so great at the present time, owing to the increased delaying power given to *troupes de couverture* by modern arms.

(2). The necessity of ensuring the enemy's defeat, before diverting troops to cut off his retreat. Napoleon despatched Masséna and Oudinot to intercept the Austrians before the latter had been beaten, and without considering the possibility of their adopting another line of retreat.

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(3). The necessity of rapid and energetic offensive action. The Archduke Charles lost a great chance of inflicting a severe defeat on the French between April 19th and 21st, when he might have crushed Davout's corps.

(4). The importance of issuing definite orders as to the destruction of bridges was exemplified by the action of the French 65th Regiment at Ratisbon; the failure to destroy the stone bridge at this place greatly facilitated the junction of the Austrian forces on and after April 22nd.

(5). The fatal mistake of underrating the enemy; Napoleon constantly underrated the Austrians throughout this campaign.

(6). The extraordinary marching powers of the French infantry.

(7). The wonderful influence of Napoleon over the troops under his command, both French and Germans.

THE ANGLO-PORTUGUESE ALLIANCE AND COAST DEFENCE. Translated by Capt. A. F. Custance, late (XXIX.) The Worcestershire Regt. By Moraes Sarmento. xvi.+206 pp., 6 plans. 8vo. London, 1908. Rees. 5s.

This is a translation of a book published in 1904. The translator points out that some of the theories put forward by the author require considerable modification owing to the changes which have taken place not only in Weltpolitik but also in our own home affairs. The reader will, however, easily recognize when this is the case. The author refers to a contract which he assumes to be of an offensive and defensive character, and the terms of which he states to have been recently (1904) ratified between Great Britain and Portugal. He examines the advantages of such an alliance to each of the contracting powers respectively, and then proceeds to discuss to what ends Portugal can most profitably devote her limited resources while at the same time fulfilling her obligations to Great Britain. After quoting many historical and contemporary examples the author comes to the conclusion that the rules laid down by Bonamico for Italy apply equally to Portugal, namely:—

(i.). To give up the illusion of attempting to defend indefensible localities by the erection of local defences.

(ii.). To give up the system of dividing coast defence into sections, which invites disaster.

(iii.). To establish a system of defence which shall consist of two large zones having Lisbon as their common base.

(iv.). To defend the latter harbour suitably on the seaward and land fronts.

(v.). To select a type of vessel which must be used exclusively for purposes of home defence under cover of the British fleet which will be engaged in holding the main lines of communication.

(vi.). To select types of torpedo-boats and scouts to suit the two separate zones in which they operate.

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Finally, having outlined the part to be played by the naval forces, the author suggests that any money left over after providing suitable defences for Lisbon should be devoted to the better organization of the army—

(*a*). To defend the land frontiers in the event of Spain being hostile.

(*b*). To co-operate with Great Britain, oversea if required, in the event of Spain being friendly or neutral.

THE TACTICS OF HOME DEFENCE. By Colonel C. E. Callwell, C.B. 206 pp. 8vo. London, 1908. Blackwood. 3s. 6d.

In his introductory chapter Colonel Callwell expresses the opinion that the influence which the peculiar topographical conditions prevailing in the United Kingdom have upon tactics has not been studied as it ought to be, and he states that the object of his book is to draw attention to that influence. He alludes to the fact that the Territorial Forces are rarely exercised in enclosed country, but generally at one of the great military camps where the ground is totally different from the country in which they might expect to fight in case of an invasion.

In the first two chapters he deals with the influence which sea transport and the enclosed character of the country are likely to exert on the composition of an enemy's force and concludes that mounted units must be largely eliminated, that artillery must be reduced, and that cyclists would be a prominent feature.

Colonel Callwell then proceeds to consider the study of ground and of topographical features, and, treating this subject in detail, he indicates the difference which the seasons make in the appearance of a country, the effect of the atmosphere, and he goes deeply into the subject of hedgerows and fences. After some general remarks on troop-leading in enclosed countries he passes on to infantry tactics, when he again insists on the tactical importance of hedgerows and on the necessity of an eye for ground; he also insists on the necessity for subordinate leaders being prepared to accept responsibility, because the difficulty of maintaining communication is enhanced in close country, and he touches on the questions of ammunition, supply, and scouts. The question of cyclists forms the subject of the next chapter, and the author is enthusiastic about the probable utility of corps of cyclists for use in the United Kingdom and their ability to take the place, in a large measure, of mounted troops, but, as he observes, since trained corps of cyclists do not exist, it is all the more important that our yeomanry should be trained to carry out the cavalry duties of an army. In the chapter on artillery tactics, Colonel Callwell deals with the difficulty of central control in enclosed country, and, consequently, the possibility of dissemination of batteries and even sections, and he also alludes to the question of the support afforded to infantry by artillery and to the selection of positions and other artillery questions. He

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considers that howitzers and mountain guns would be most useful, but that heavy guns would not be so.

The book closes with a chapter on positions, their occupation and preparation for defence, and the pith of it may be summed up in the author's words:—"It cannot be too strongly insisted upon that the paramount requisite of a position is that the locality chosen should comply with the plan of operations, and that it should satisfy the general situation in the theatre of war."

The book will be read with interest by all students of the subject, and there are many points which the author brings out the consideration of which will prove instructive to all soldiers. The book is written in the easy readable style with which all readers of Colonel Callwell's books are familiar.

THE FIGHT ABOUT FORTIFIED FIELD POSITIONS (Der Kampf um befestigte Feldstellungen). By Major von Fritsch (Instructor at the Staff College in Berlin). 68 pp., 3 maps. 8vo. Berlin, 1908. Liebelsche Buchhandlung. 4s.

This is a book, written by an expert, offering much valuable instruction on the important subject of fortified field positions.

The author divides his work into two parts, the first dealing with theoretical principles, the second with the application of these principles. As Major Fritsch explains in his preface, the first part is not intended to be in the nature of a manual on the fight about fortified field positions, but rather explains and discusses a series of conceptions and questions on the subject.

The second part gives a set of three problems, under the headings: (A) Choice of a position; (B) Defence; (C) Attack; and furnishes, in each case, an interesting solution of the problem, worked out in considerable detail.

A special map is provided for each problem.

INTELLIGENCE AND SCOUTING.

RECONNAISSANCE IN THE RUSSO-JAPANESE WAR. By Asiaticus. Translated from the German by Lieut. J. Montgomery, 3rd Hussars. 147 pp., with plans. London, 1907. Rees. 4s.

The book opens with an introduction which briefly outlines the way in which cavalry should carry out its reconnaissance duties. The writer then deals with the characteristics of the two cavalries, but he throws no very new light on this subject. He then gives a rather remarkable account of the way in which the Japanese organized a system of espionage, which they were able to carry out owing to their knowledge of the natives and how to treat them.

The first study in this book is that of Mishschenko's Cossack brigade in Northern Korea. The action of the cavalry on both sides is criticized, and, in the author's opinion, the Japanese worked their cavalry considerably the better of the two.

The next four chapters deal with Rennenkamp's reconnoitring

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activity round Sai-ma-chi, and here again the Russian comes in for a considerable amount of criticism, though the author praises the marching power of the Cossacks. It seems that the Russians never attempted to surprise the Japanese, while frequently surprised themselves, and the lack of the most ordinary precautions, both in camp and on the march, is hardly credible. It is, as the author says, an example of how a commander, "full of zeal, self-sacrifice, and energy, as Rennenkampf undoubtedly was, was unable to bring to a successful issue his given task. . . . What was the net result of all this activity? Really nothing at all."

The next chapter describes the operations of the 1st Japanese Cavalry Brigade, under Major-General Akiyama, from 30th May to 16th June, 1904. Here, again, the author severely criticizes the Russians, and praises the Japanese; and the energy and enterprise of Akiyama certainly seem in striking contrast to the apathy and lack of vigour of the Russians.

The next operation dealt with is Mishchenko's raid on Ying-kou in January, 1905. In this raid we find the Russian leader altering his plan and diverting his force to a secondary objective, with the result that the enterprise failed with considerable loss. The Russian want of precaution is shown by the fact that this force, entirely composed of cavalry, was surprised by infantry.

The book concludes with a review of the work done, and considers what new methods and measures have established a claim to future consideration and may be applicable to European theatres of war. The author considers that the value of cavalry has not in any way suffered by the experiences of the war, but that its training and employment seem to be a matter of increasing difficulty.

The book generally is well worthy of the attention of cavalry and general staff officers. The maps are clear, but are often inserted in inconvenient places.

INSTRUCTIONAL.

BATTLE ORDERS (Gefechtsbefehle). By Lieut. von Kiesling. 89 pp., 2 maps. 8vo. Berlin, 1907. Eisenschmidt. 3s.

This is a study of the orders written and given during an action in a division and in its brigades and regiments. The author remarks very justly in his preface that the writing of orders for and during a battle is not so much practised as the preparation of march, halt, and deployment orders; in consequence, while there are numerous junior officers who can draft orders of the latter categories, there are very few who understand what orders are possible during a battle, and how they should be given.

The specimens of orders presented by the author, while absolutely clear, are models as regards brevity; the author writes the names of units in the body of the orders in thick fat letters so that they strike the eye and cannot well be overlooked by the receiver, who is thus

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enabled to see at once whether his unit is concerned and, if so, what is expected of it.

The following order is extracted to show the style; it is longer in English than in German, as such useful words as *marschbereit* (prepared to march at any moment) and *nächtigen* (to pass the night) are not available in our language.

P...23.11. 6.30 P.M. Divisional Order No. 4 for the 23.11.

1. *Enemy* beaten, withdrawing everywhere.

2. *Army* pursues to-day 23, as far as A.. 2nd Division with left wing *viâ* Y... M...

3. 1*st Division* pursues *viâ* K... towards F...

4. 11*th Infantry Brigade*, plus 2nd Hussars and 7th F.A.R., advances on B... and seizes the bridge there.

5. 1*st Infantry Brigade* advances into area Y... and B.. 2*nd Infantry Brigade* into area G .. and K..., where they will probably pass the night. They will cook and make ready for the night, but be prepared to march at any moment. S.A.A. wagons and 2nd line transport not yet up will be sent on by the Division.

6. *Divisional Staff* until 7 at P... afterwards B..., where order-receivers to be 7.30 P.M.

TRAVEL AND TOPOGRAPHICAL.

THE AMU DARYA AND ITS FLOTILLA. By Colonel V. I. Treteski. 57 pp. 8vo. Charjui, 1906. K. M. Baranov. 8d.

A concise account of the small flotilla of steamers and barges which the Russian Government maintains on the Amu Darya (Oxus River) with the dual object of supplying a means of communication to and from the military posts on that river and of facilitating the transit of passengers and private goods through Southern Bokhara.

The author, who is the Commandant of the flotilla, prefaces his work by stating that his object in publishing it is to emphasize the commercial rather than the strategical importance of the flotilla, in the hope that the attention of the public may thus be drawn to the advantages which might accrue from an extension of its capabilities.

The subject is divided into the following headings, viz.:—

(i.). Historical sketch of the origin and development of the flotilla.
(ii.). Its strength and composition.
(iii.). Brief description of the Amu Darya, and notes on its navigability.
(iv.). Details of construction and carrying capacity of vessels.
(v.). Ports and landing-stages on the Amu Darya.
(vi.). Commercial significance of the flotilla.
(vii.). General *raison d'être* of the flotilla.
(viii.). The climate of the Amu Darya.
(ix.). Graphic table showing rise and fall of the Amu Darya by months during the period 1886–1905.

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FROM THE NIGER TO THE NILE. By Lieut. Boyd Alexander. 2 vols., about 400 pp. each, with maps and illustrations. 8vo. London, 1907. Arnold. 36s.

These two volumes contain the record of an exceedingly interesting journey across Africa, which, as an exhibition of endurance and persistence, has not been equalled since the days of the pioneer explorers. The chief fact which emerges is that it is possible, or rather nearly possible, to go across the continent from west to east in a boat. During a journey which lasted three years, Mr. Alexander was only obliged to carry his boat for 14 days.

As regards the geographical work accomplished, the most important piece of mapping carried out by the expedition is the strip surveyed by the late Capt. Claud Alexander and Mr. Talbot between Ibi on the Benue and Lake Chad, a strip about 550 miles long and of varying width. This is a useful addition to the material at our disposal for the formation of maps of N. Nigeria.

Some time was spent in exploring Lake Chad. It appears that the lake was at a lower level than was the case at the time of Capt. Tilho's explorations, and Mr. Alexander found it impossible to journey by boat from the western portion of the lake into the eastern. A map of the lake is bound up in the second volume. The map is constructed from traverses carried out by Mr. Boyd Alexander and Mr. Talbot, and is adjusted to four points previously fixed astronomically by the French. It is, indeed, to the French that we owe the bulk of present knowledge of Lake Chad, and the work of Tilho, d'Adhemar, Andoin, and others of the same nationality should never be forgotten in discussing the shape and character of the lake. It was by the French that the first exact map of Lake Chad was made, and it is chiefly on their fixed points that additional information is adjusted.

The river Bamingi (meaning "Plenty Water") was ascended for about 130 miles; it had never been previously explored.

Instead of a five-day march from Yei, a Belgian post, to Rejaf on the Nile, Lieut. Alexander determined to try and find a waterway to the Nile by using the Yei River. Little was known of the river, but it was believed to fall into the Bahr-el-Ghazal at Meshra-el-Rek. The author shows that it is navigable in its lower reaches and could be used to shorten by six days the transport of supplies to our garrisons in the Bahr-el-Ghazal province which are entirely dependent on Khartoum for their corn. The Yei was found to terminate in marsh and sudd, but Lieut. Alexander believes that if this sudd, and that in the parallel river, the Naam or Rohl, was cut through, the increased water supply to the Nile would greatly improve the irrigation of the Sudan and Egypt.

Though most of this eventful journey was made by water, still, from a strategic and also commercial point of view, this route is useless owing to lack of water in many portions of it for several months in the year. Lieut. Alexander points out that sleeping

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sickness, which has only of recent years been known in the Lado Enclave, is gradually making its way up to the Bahr-el-Ghazal.

Great credit is due to Lieut. Alexander and his party for the manner in which they dealt with the natives; much of the country passed through was very unsettled and inhabited by most truculent tribes. In spite of this, there never was any serious trouble, and most useful information was gained of many hitherto almost unknown tribes. It would be difficult to find a better lesson in the treatment of and conduct towards natives than is contained in the pages of these two most interesting volumes.

MISCELLANEOUS.

MILITARY QUESTIONS OF TO-DAY (Questions militaires d'actualité). 2nd series. By General H. Bonnal. 287 pp. 12mo. Paris, 1908. Chapelot. 3s.

This is a series of short essays on a comprehensive variety of military subjects. The first is a forecast of what will be the strategy and tactics of both belligerents, but more especially the Germans, in the next Franco-German War. The next two in importance are "The Effect of the Two Years' Service Law" and "The Organization and Employment of Cavalry." In the former of these a comparison is made of the respective strengths of the military forces of France and Germany.

Among the other subjects dealt with are:

The Duties of the Staff;
The Character of Commanders;
Discipline;
A National Army; and
The German Imperial Manœuvres of 1906.

SOME NEGLECTED ASPECTS OF WAR. By Capt. A. T. Mahan, United States Navy, H. S. Pritchett, and Julian S. Corbett. 193 pp. 8vo. London, 1908. Sampson Low. 6s.

This book is a reprint of articles and lectures and contains the following:—

The Power that Makes for Peace. By H. S. Pritchett.
The Capture of Private Property at Sea. By Julian Corbett

and

The Moral Aspect of War;
The Practical Aspect of War;
War from the Christian Standpoint;
The Hague Conference of 1907, and the Question of Immunity for Belligerent Merchant Shipping;

all by Capt. Mahan.

It is unnecessary to commend the writings of Capt. Mahan and Mr. Corbett to the officers of the Army, they are already sufficiently

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well known and Mr. Pritchett appears worthy of his company. The subjects of the essays are sufficiently indicated by their titles, and the object of collecting them under one cover is given by Capt. Mahan in the preface as follows:—

"Convinced that the cause of peace is jeopardized by the exaggerations and oversights of its noisier followers, I have thought it expedient to collect under one cover a few articles in which the rationale and justification of war and its procedure have been considered under different aspects."

Many points could be noted in these essays which are of interest and value, but it will be enough to say that the high reputation of the authors is well maintained, and the book should be read by all interested in questions of international policy and of arbitration.

THE INDIA OF THE FUTURE. Reprint of articles in the *U.S. Magazine* by Colonel L. J. H. Grey, C.S.I., with a preface by Lieut.-General Sir Edmond R. Elles, G.C.I.E., K.C.B. 52 pp. London, 1907. Clowes. 1s.

The author considers that the problem of the defence of India is to be solved by the gradual devolution of administration and of provision of the means of defence upon the Indian chiefs and nobles.

He advocates the extension of the system of Imperial Service Troops, estimating that it would eventually give us an army of 200,000 men. He considers that the natural result would be the transfer of the Imperial Service Troops from the control of the Foreign Office to that of the Commander-in-Chief, but General Elles is of opinion that the Imperial Service Troops should remain generally under the administration of the Native States, and that any transfer to the Commander-in-Chief would be resented by the chiefs as an unnecessary interference.

POCKET HANDBOOK OF THE WORLD'S NAVIES (Taschenbuch der Kriegsflotten, 1908). By B. Weyer. 468 pp., with photos and diagrams. 8vo. Munich, 1908. J. F. Lehmann. 1s. 6d.

Contents. Part I.—Lists of ships of various navies, with diagrams of types. Part II.—Comparisons of the chief navies. Part III.—Artillery. Part IV.—Miscellaneous. Part V.—Tables, etc.

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PLATE II.

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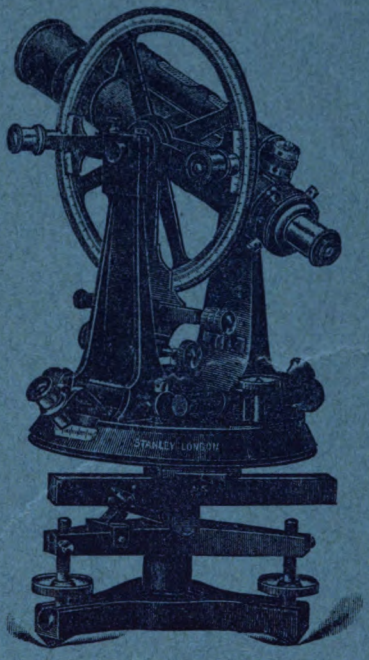

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The following Officers, whose names are arranged in regimental order, were successful from us at the recent Competitive Examination for admission to the Staff College.

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,, W. H. Moore, D.S.O., R.G.A.
,, J. P. Mackesy, R.E.
,, B. W. B. Bowdler, R.E.
,, F. D. Farquhar, D.S.O., Coldstream Guards.
*Capt. R. G. Parker, Rl. Lancaster Regt.
Capt. G. N. T. Smyth-Osbourne, Devonshire Regt.
Capt. V. H. M. de la Fontaine, East Surrey Regt.
Capt. and Bt. Major F. R. Hicks, Hampshire Regt.
Capt. H. S. Williams, Dorsetshire Regt.
,, B. D. L. G. Anley, D.S.O., Essex Regt.
Capt. R. S. Hamilton-Grace, Durham Light Infantry.
*Capt. H. F. Baillie, Seaforth Highlanders.
,, P. S. Allen, Gordon Highlanders.
,, J. K. Cochrane, Leinster Regt.
,, R. L. Ricketts, Indian Army.
,, W. K. Bourne, Indian Army.
,, F. W. Lumsden, R.M.A.

The following Officers received nominations:—

Capt. H. C. Bickford, 6th Dragoon Guards.
Capt. C. J. C. Grant, Coldstream Guards.
Capt. W. D. Wright, V.C., Royal West Surrey Regt.
Capt. C. H. Harington, D.S.O., Liverpool Regt.
Capt. H. Wake, D.S.O., King's Royal Rifle Corps.
Capt. and Bt. Major N. J. G. Cameron, Cameron Highlanders.
Capt. G. P. Grant, D.S.O., Indian Army.

SANDHURST, JUNE, 1906.

FIRST	A. G. Armstrong 5,541	129th	R. P. T. Ffrench..... 3,827
48th	H. G. Gauntlet 4,515	181st	C. W. Molony..... 3,445
67th	D. Macdonald..... 4,299	186th.....	P. J. I. Synnott 3,386
89th	W. G. Bagot-Chester..... 4,115	190th.....	R. M. Aylmer 3,339
90th	A. G. Ottley 4,109	197th.....	O. Gough..... 3,262
93rd	A. P. Williams-Freeman 4,094	201st	P. W. J. A. Stomm 3,151
115th	D. M. Black 3,940	213th.....	B. W. Molony 2,881
125th	W. J. King-King 3,846		

WOOLWICH, JUNE, 1906.

31st ... ... J. S. Barkworth 6,483

DECEMBER, 1905.

SECOND ...	H. G. MacGeorge 7,196	16th	R. Crofton 6,330
FOURTH...	G. Walton 7,046	45th	D. Stephenson 5,899
FIFTH	H. A. Cox 6,967	54th	J. Kennedy 5,711

This was the First Examination under the new regulations, and our pupils secured THREE out of the first FIVE places.

MILITIA COMPETITIVE, MARCH, 1906.

A. E. Hardy	2,304	W. F. Anderson	1,947
N. H. Hutcheson	2,105	D. C. Robinson	1,879
F. D. Frost*	1,949	F. A. Bowring	1,876

*Read partly at the Army College, Aldershot.

ARMY QUALIFYING, 1906.

Nineteen passed.

Special Arrangements have been made for the Army Qualifying in next Examination.

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